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(54) **REBAR TYING DEVICE**

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B21F 15/00 (2006.01)
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CPC B65B 13/025; B65B 13/027; B65B 13/28; B65B 13/285; B65B 13/22; B65H 59/04;
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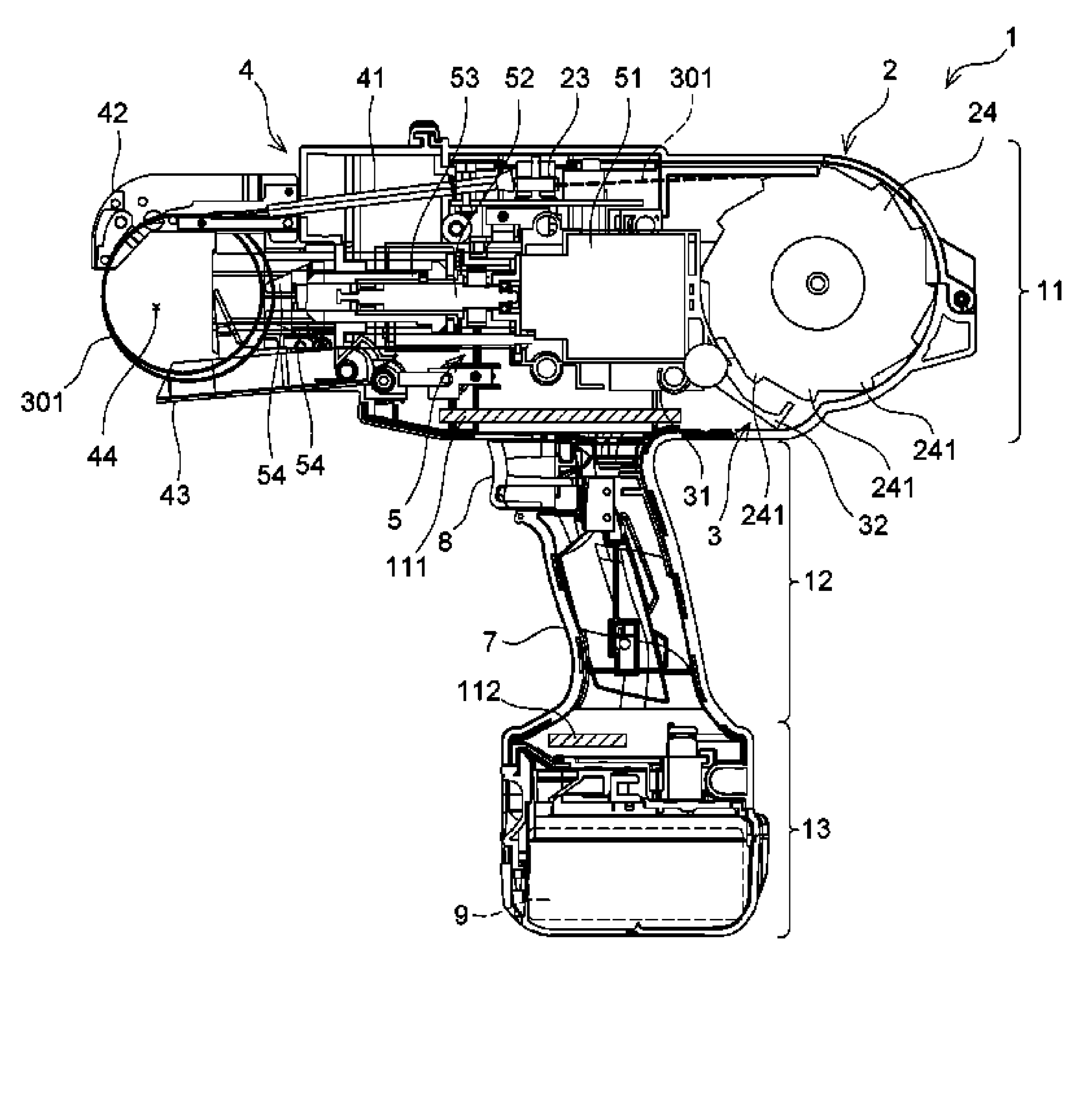
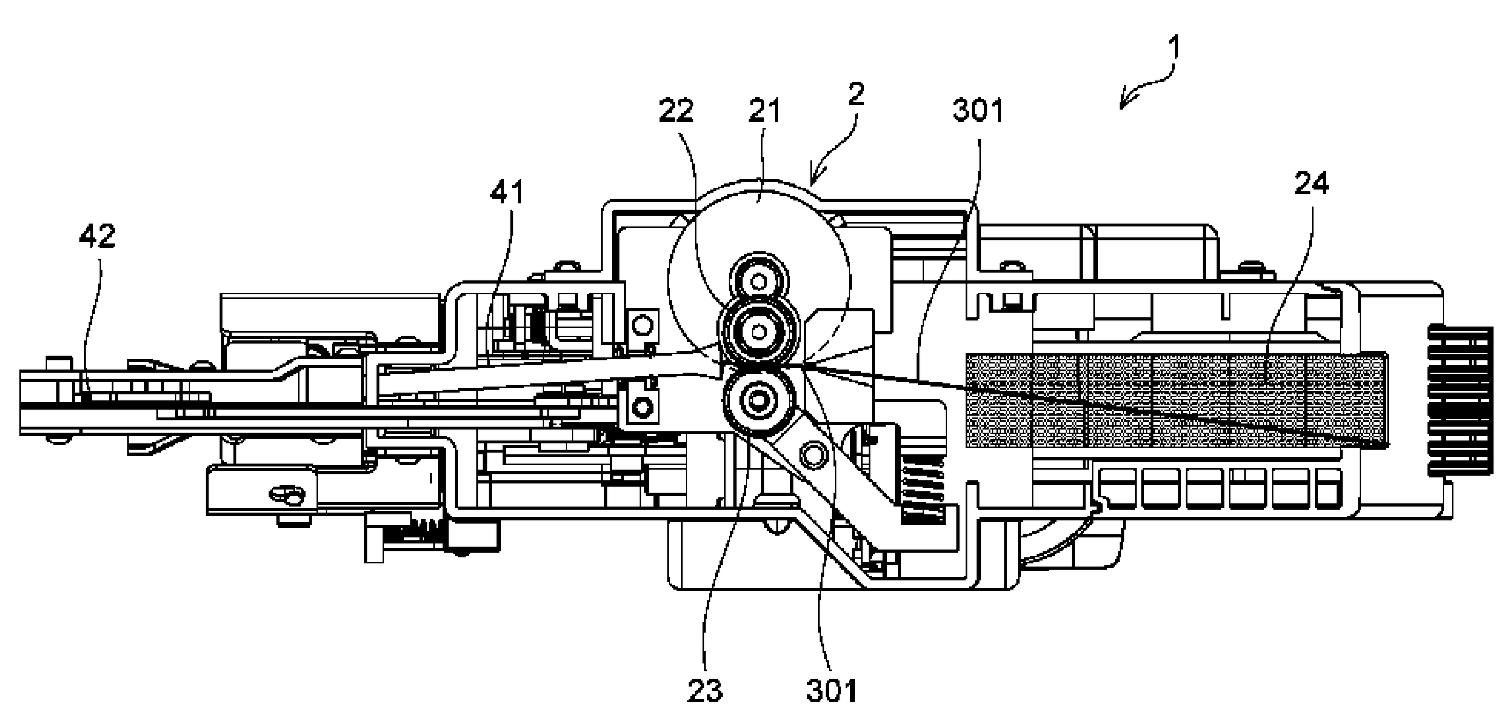
(57) **ABSTRACT**

A rebar tying device is configured to tie a plurality of rebars by a wire. The rebar tying device includes a feeder configured to feed the wire wound around a reel by a rotation of a feeding motor; a guide configured to guide the wire fed by the feeder to around the plurality of rebars; a cutter configured to cut the wire fed by the feeder at a predetermined position; a twister configured to twist the wire around the plurality of rebars; a battery configured to supply power to the feeding motor; and a control unit. The control unit configured to control a feeding length of the wire by controlling an energizing time of the feeding motor based on a predetermined feeding length of the wire.

15 Claims, 11 Drawing Sheets





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(58) **Field of Classification Search**
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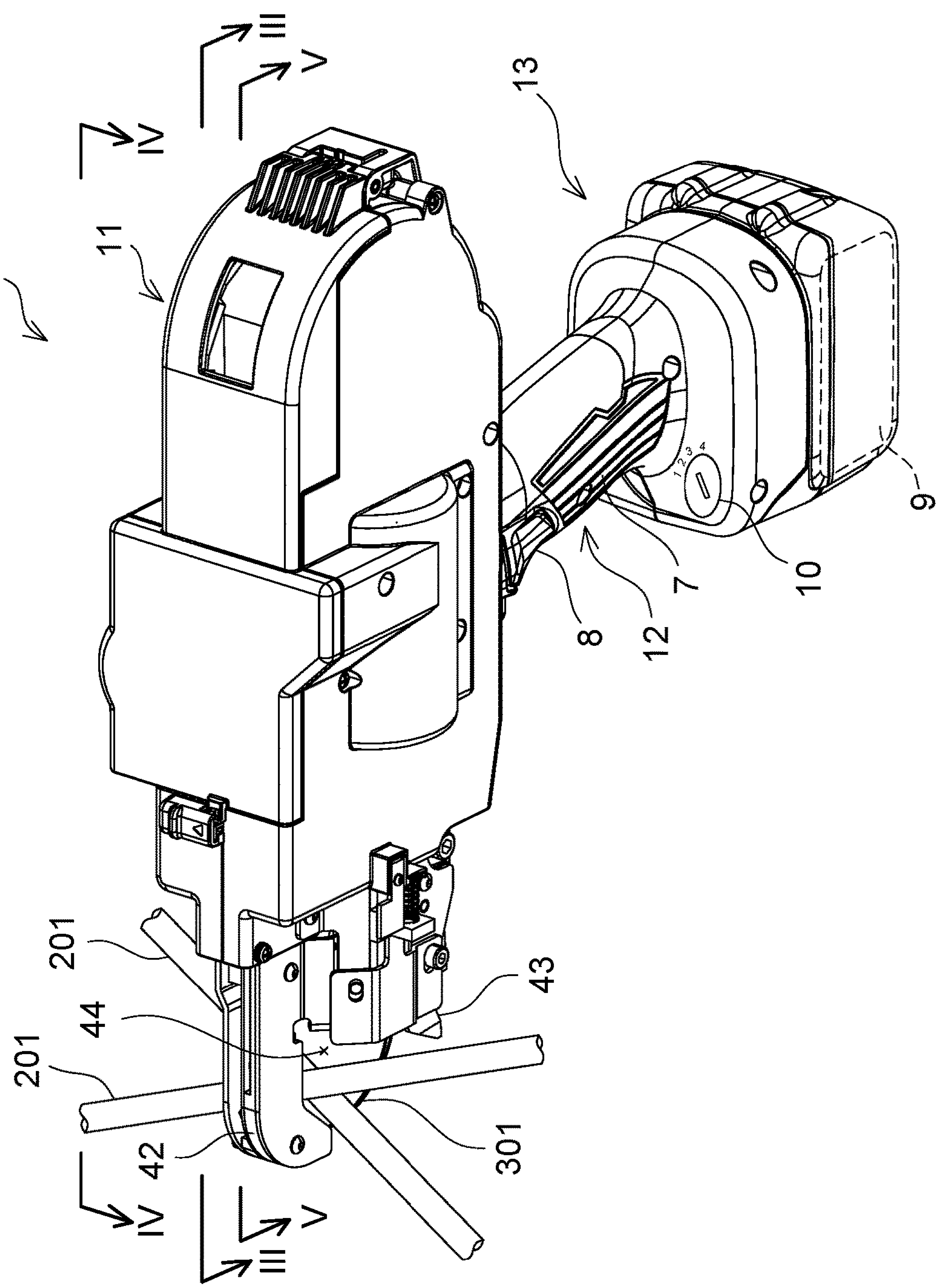


FIG. 1

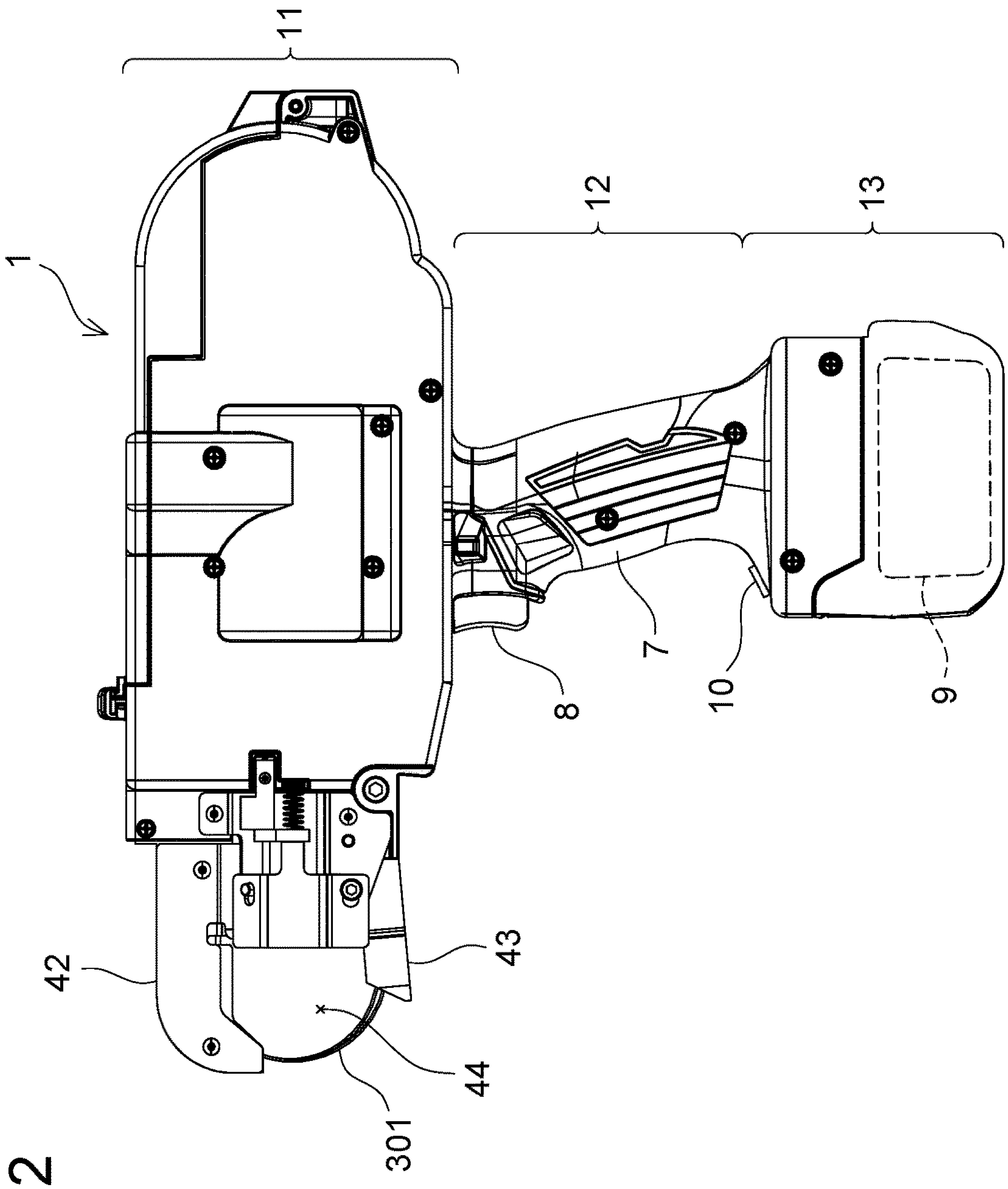


FIG. 2

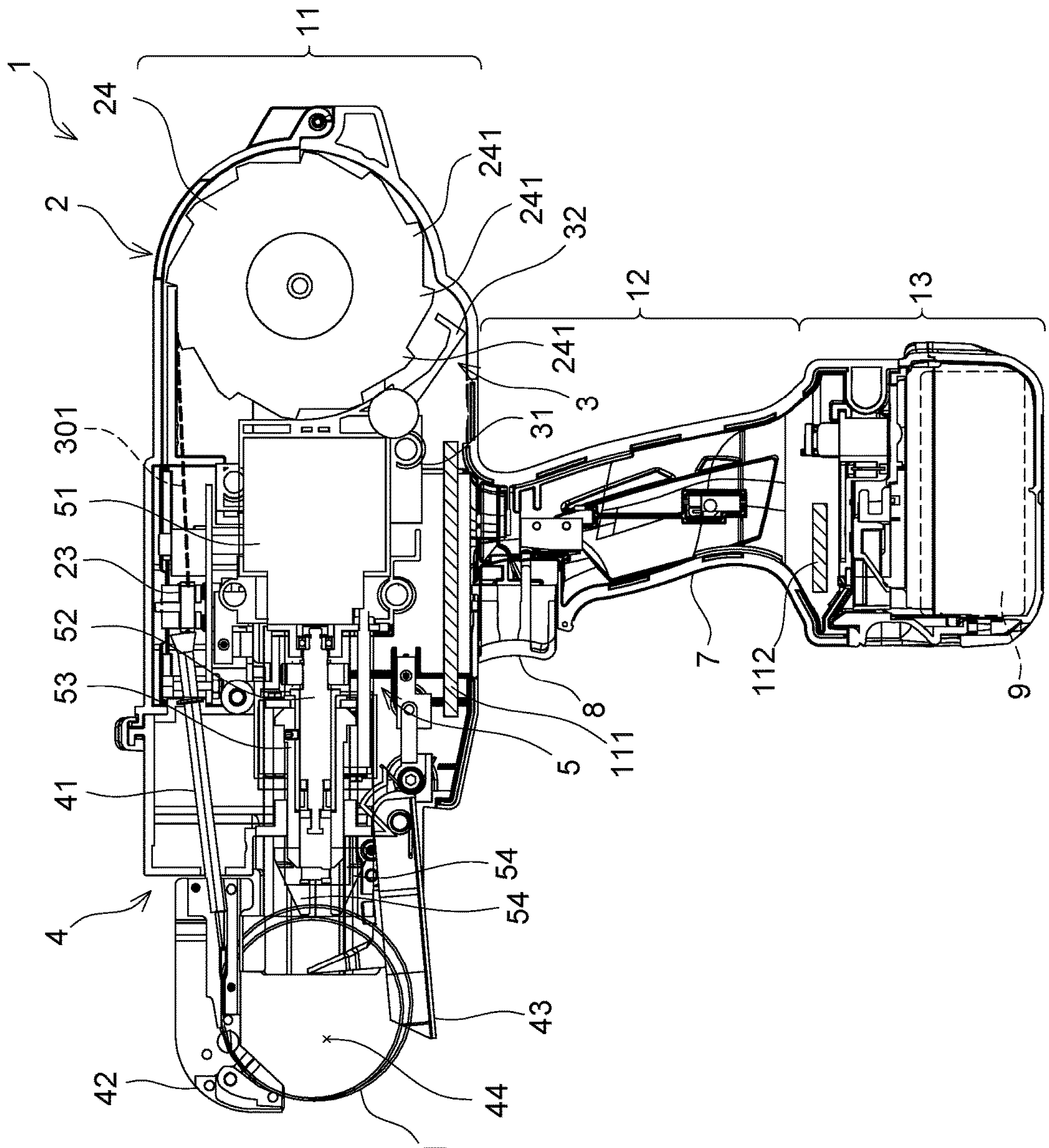

1
2
24
241
241
32
241
3
11
12
13
31
301
51
23
52
53
41
4
54
54
43
44
42
301
5
111
8
7
112
9

FIG. 3

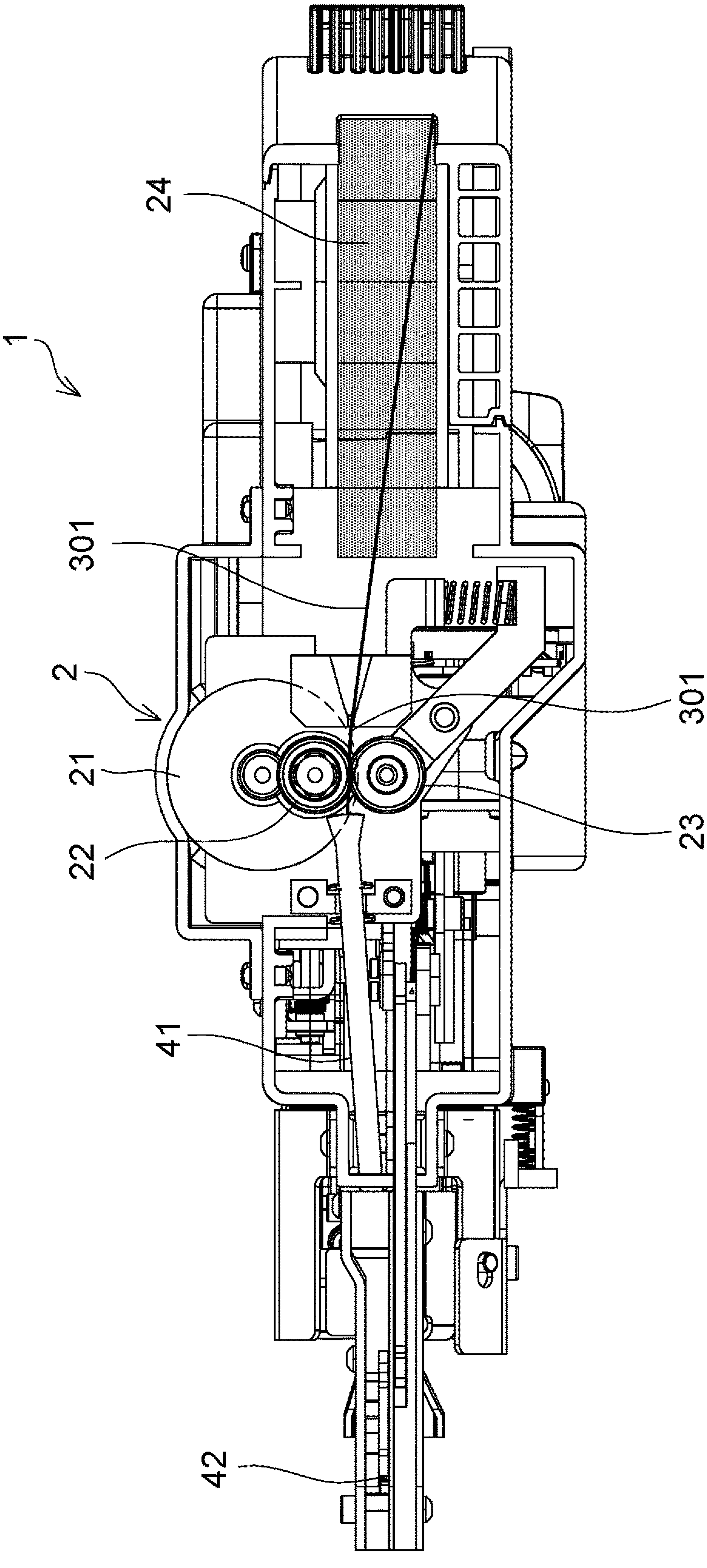


FIG. 4

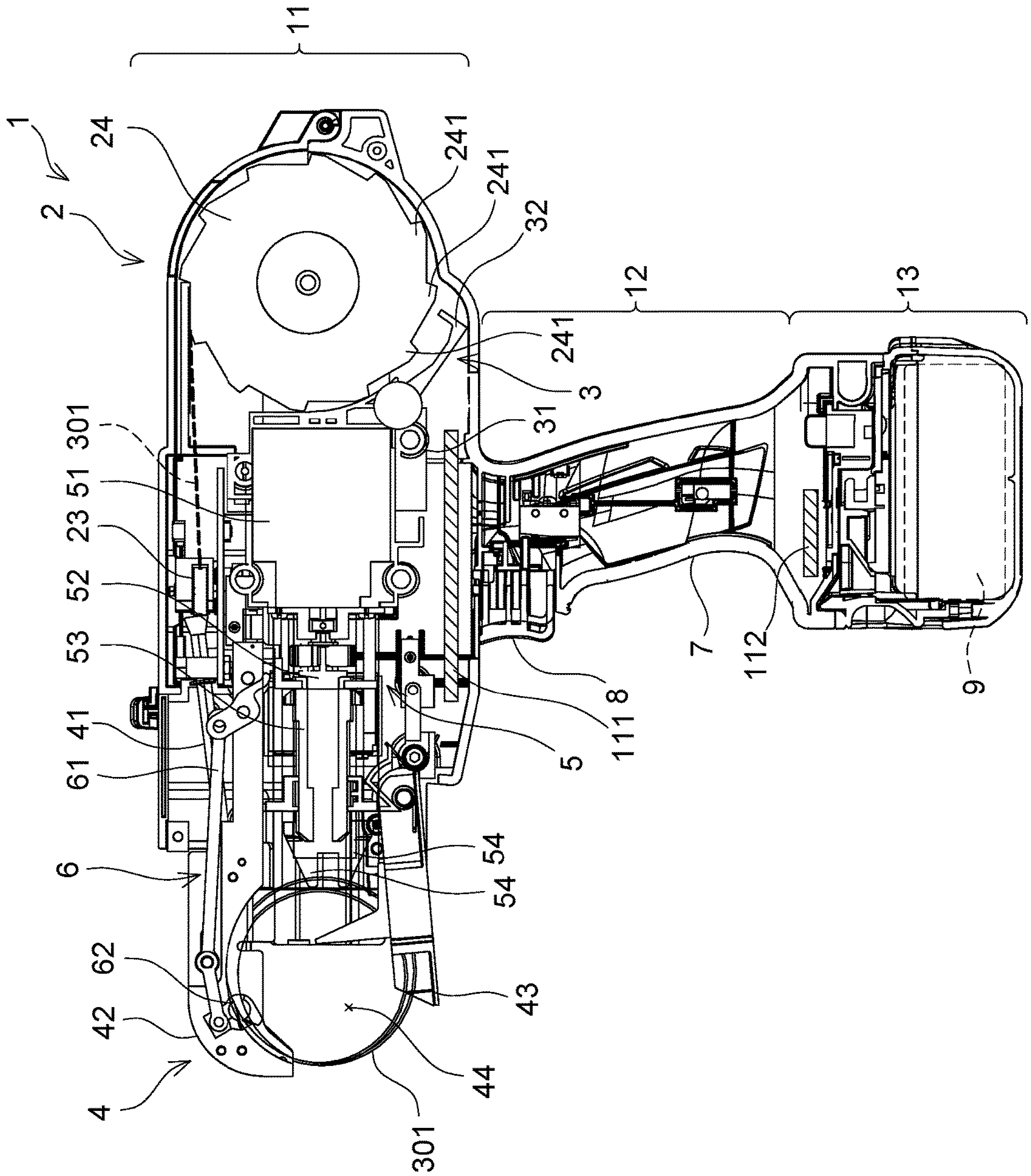

11
1
2
24
241
241
32
241
3
12
13
31
301
51
23
52
53
61
41
5
111
8
7
112
9
6
54
54
62
42
43
44
4
301

FIG. 5

FIG. 6

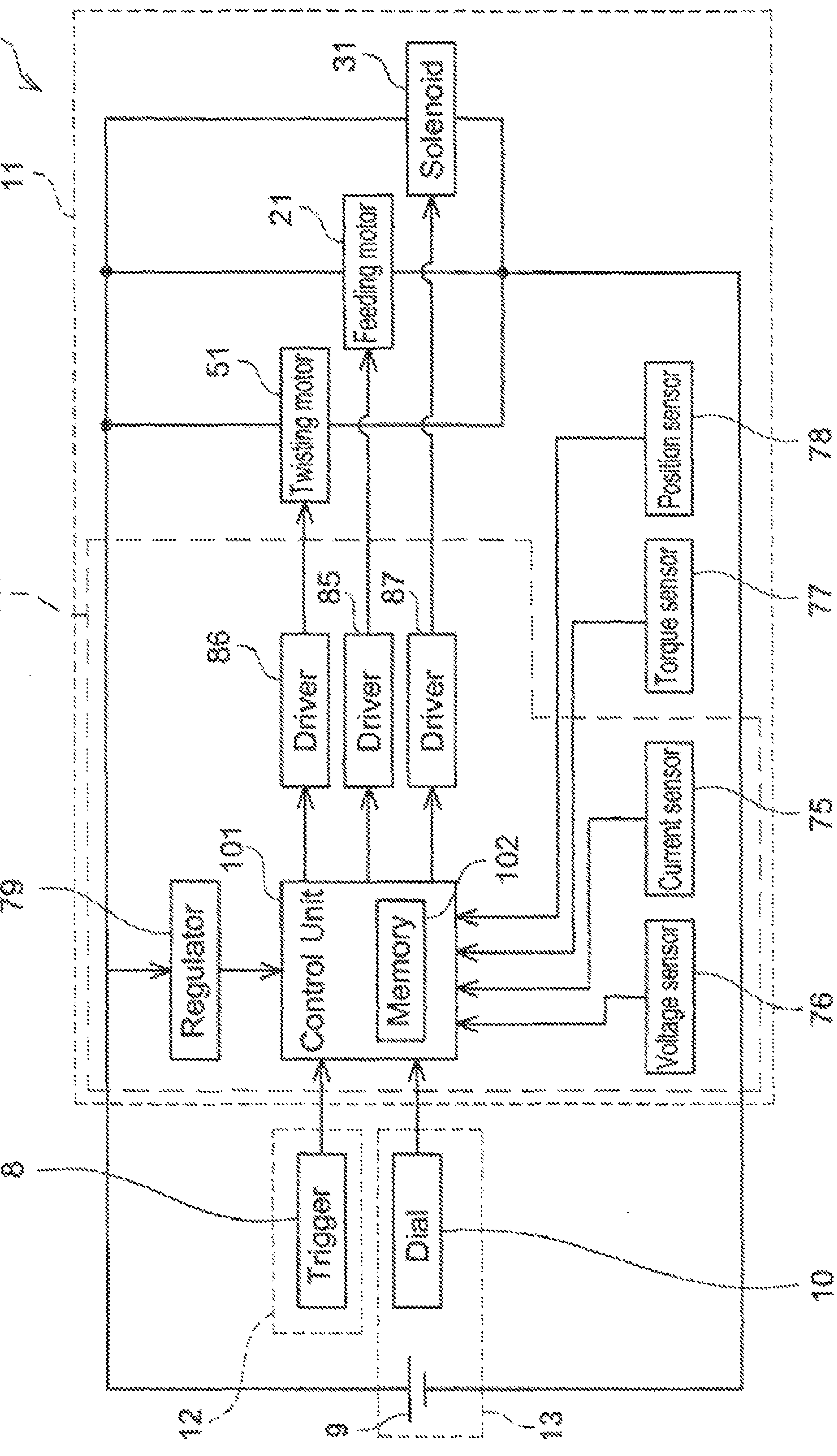

1
11
31
Solenoid
21
Feeding motor
51
Twisting motor
111
86
Driver
85
Driver
87
Driver
79
Regulator
101
Control Unit
Memory
102
Position sensor
78
Torque sensor
77
Current sensor
75
Voltage sensor
76
8
Trigger
Dial
10
12
9
13

FIG. 7

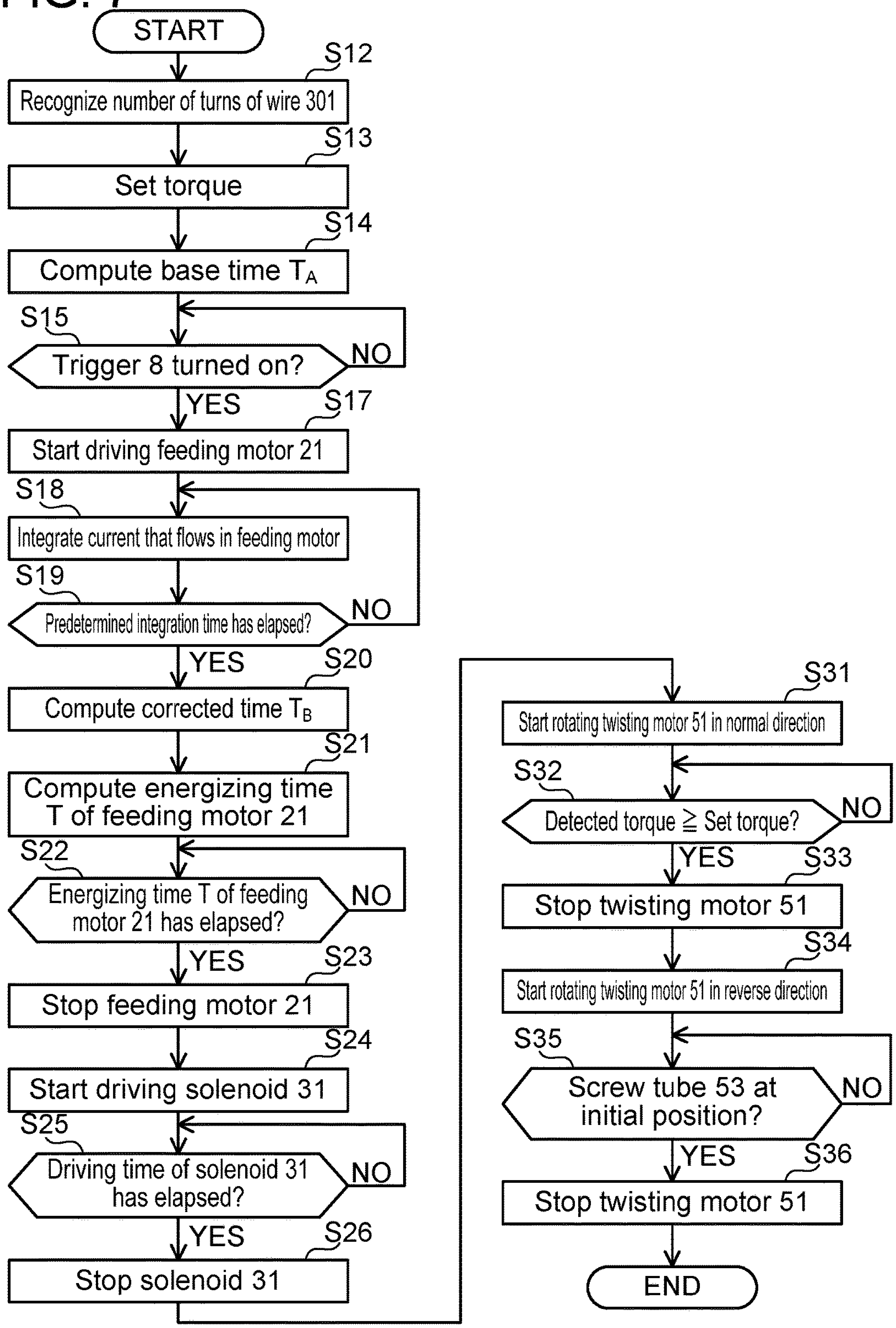

START
S12
Recognize number of turns of wire 301
S13
Set torque
S14
Compute base time T_A
S15
Trigger 8 turned on?
NO
YES
S17
Start driving feeding motor 21
S18
Integrate current that flows in feeding motor
S19
Predetermined integration time has elapsed?
NO
YES
S20
Compute corrected time T_B
S21
Compute energizing time T of feeding motor 21
S22
Energizing time T of feeding motor 21 has elapsed?
NO
YES
S23
Stop feeding motor 21
S24
Start driving solenoid 31
S25
Driving time of solenoid 31 has elapsed?
NO
YES
S26
Stop solenoid 31
S31
Start rotating twisting motor 51 in normal direction
S32
Detected torque ≧ Set torque?
NO
YES
S33
Stop twisting motor 51
S34
Start rotating twisting motor 51 in reverse direction
S35
Screw tube 53 at initial position?
NO
YES
S36
Stop twisting motor 51
END

FIG. 8

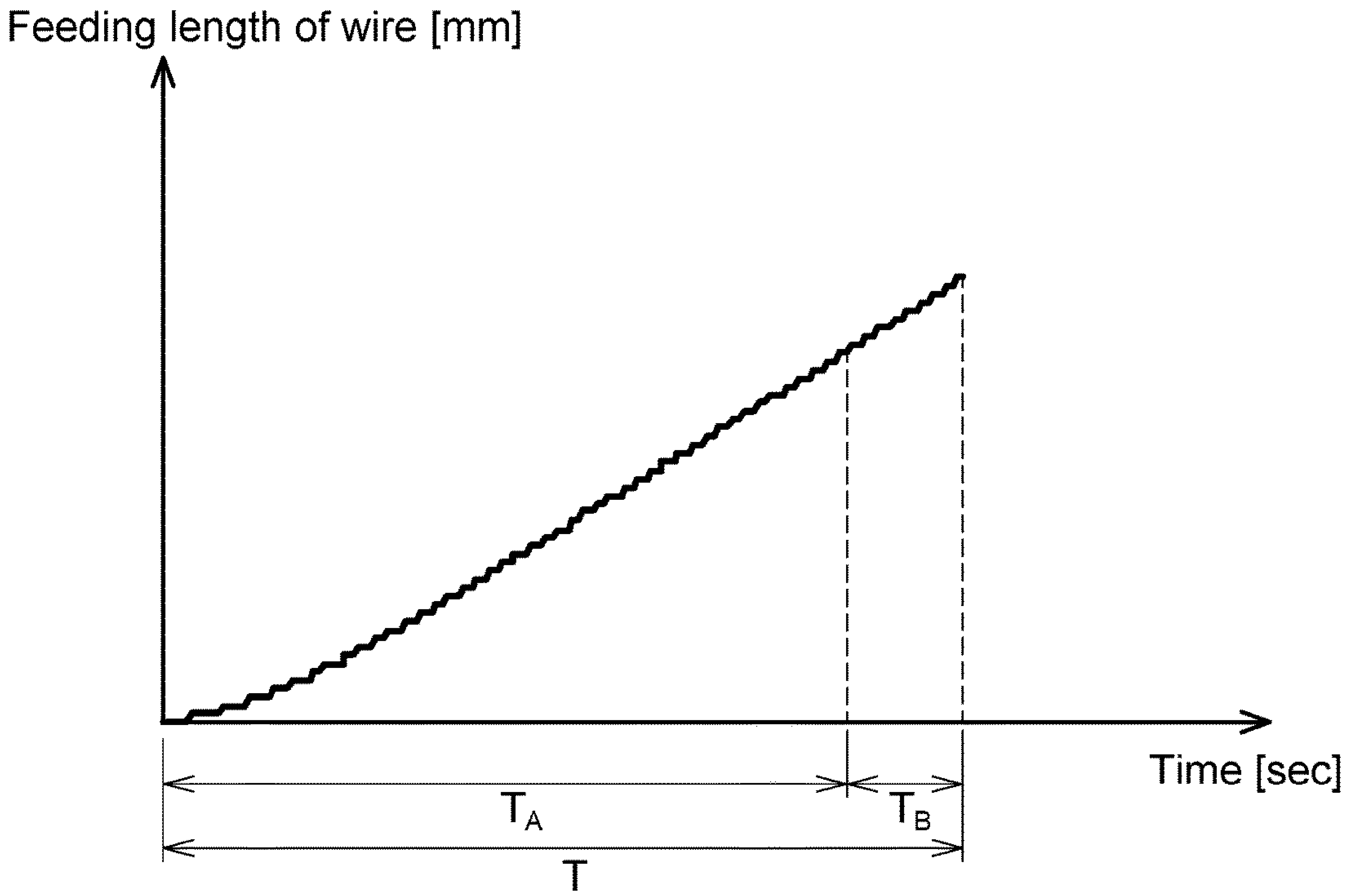

Feeding length of wire [mm]
Time [sec]
T_A
T_B
T

FIG. 9

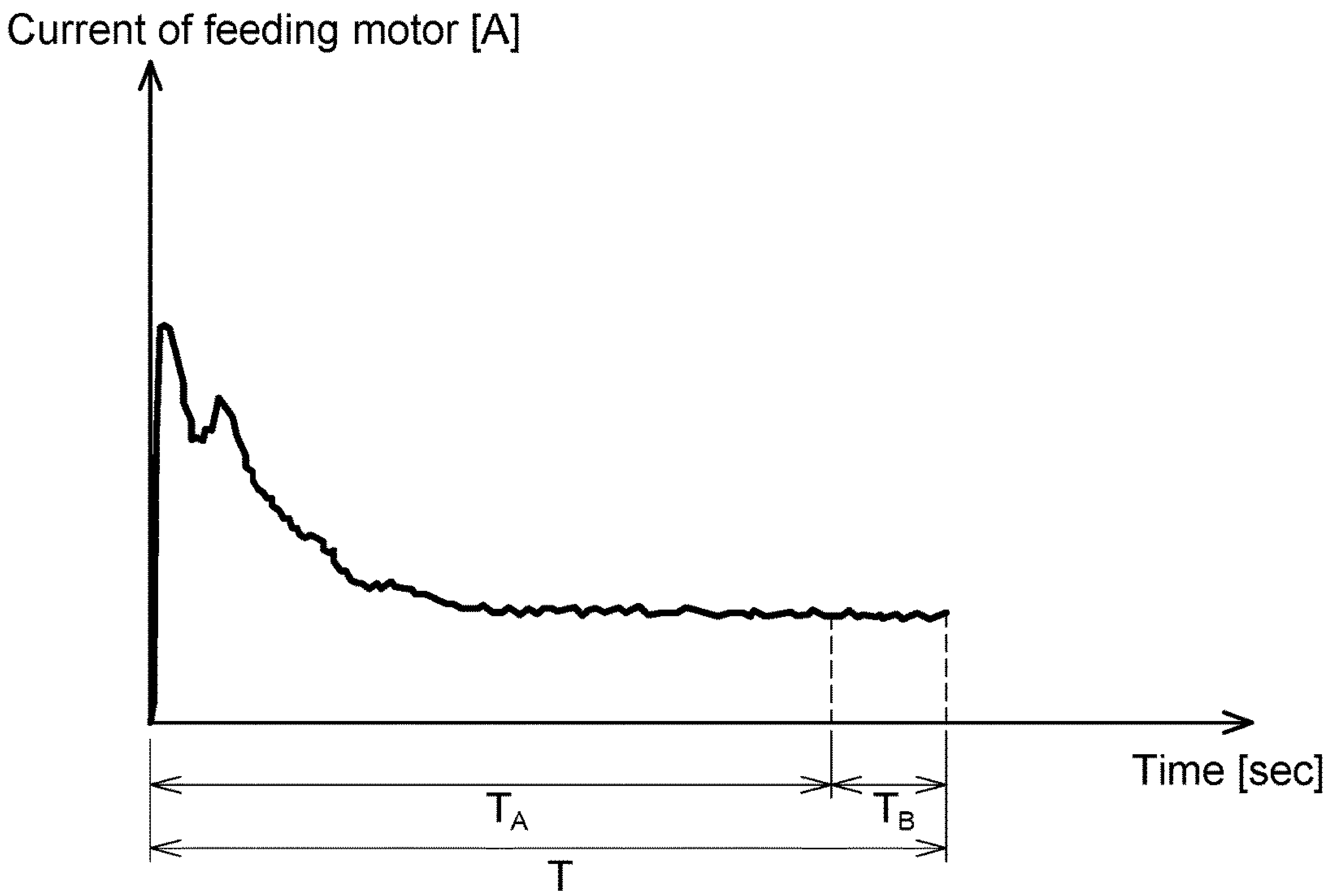

Current of feeding motor [A]
Time [sec]
T_A
T_B
T

FIG. 10

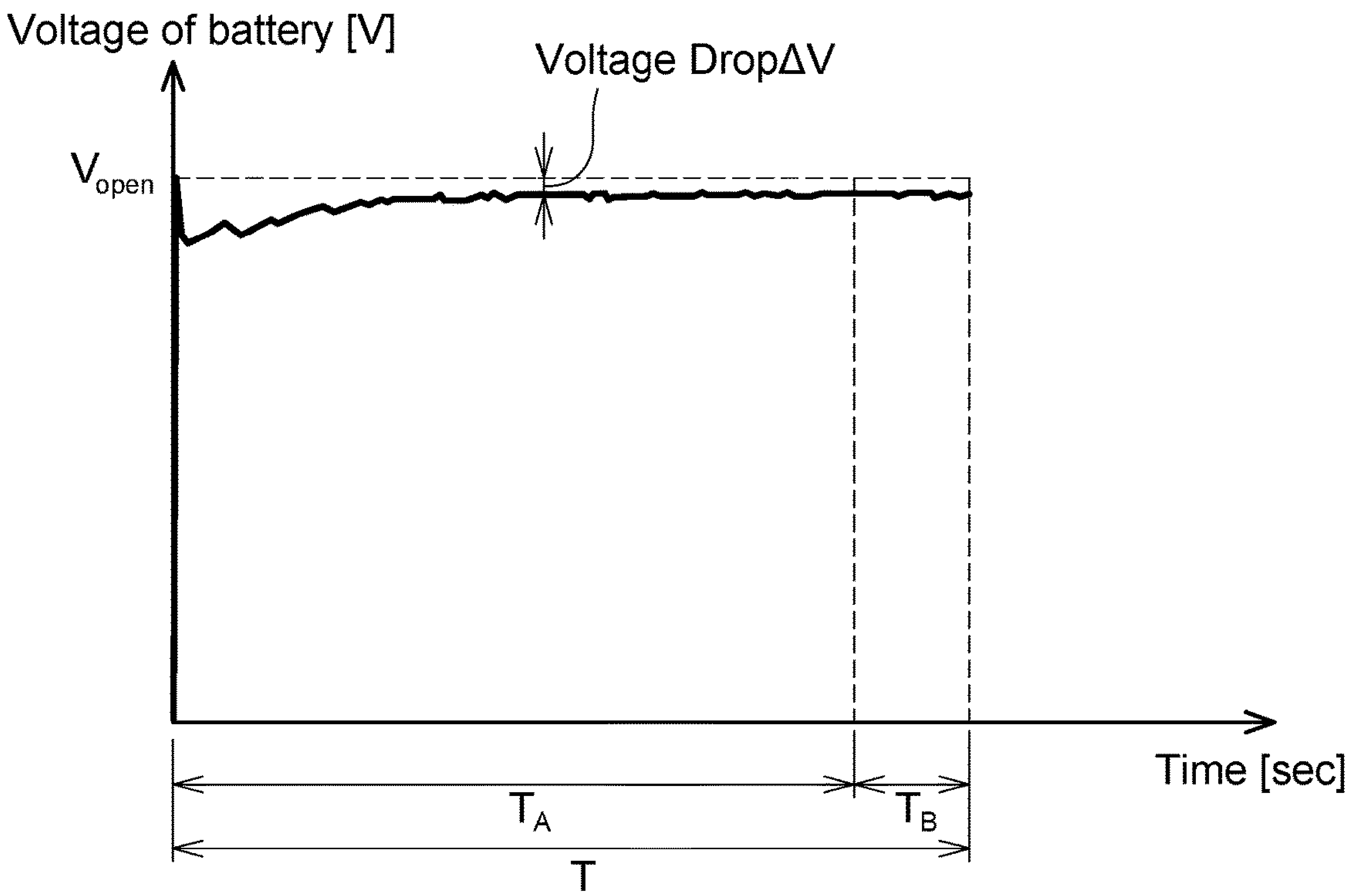


FIG. 11

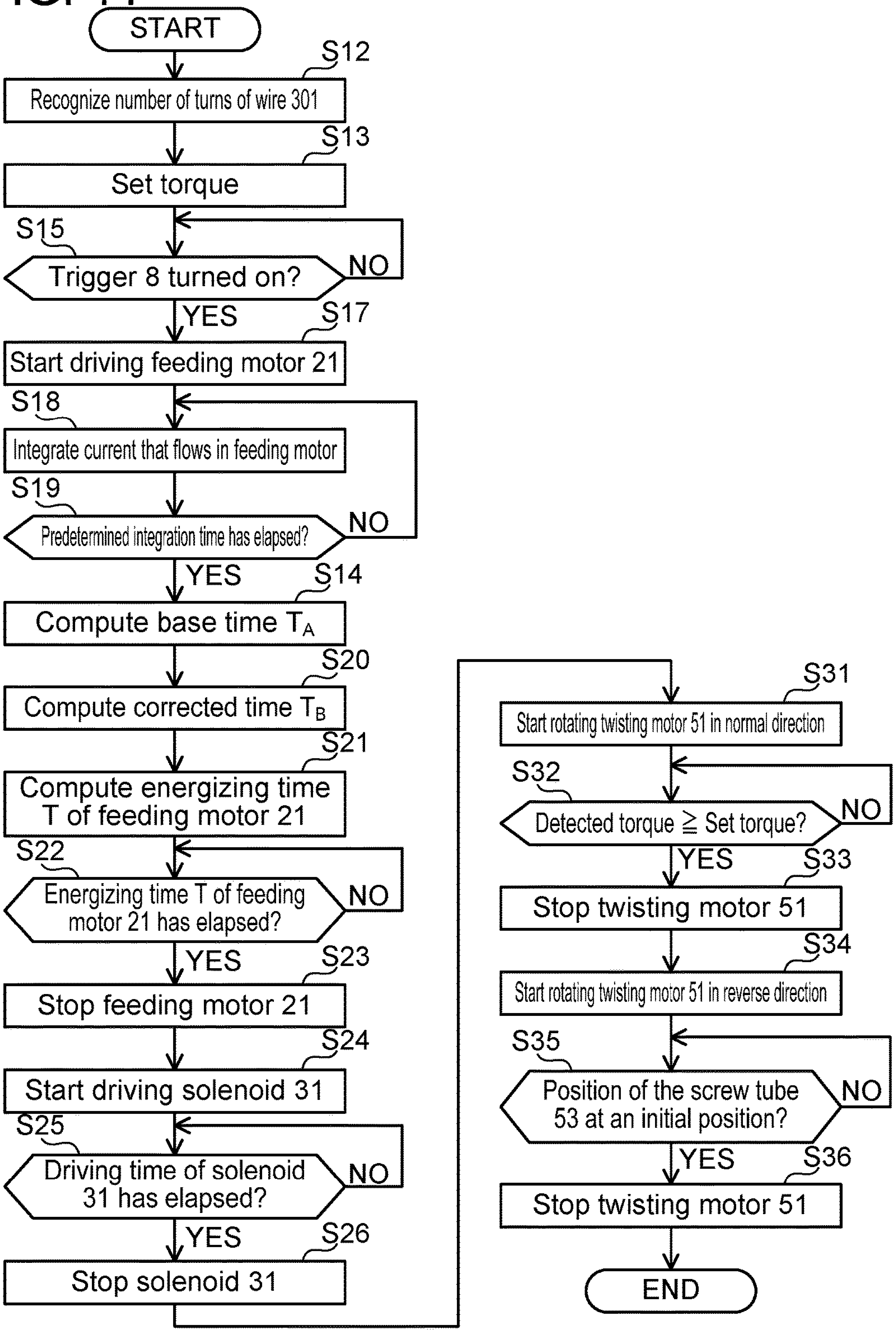
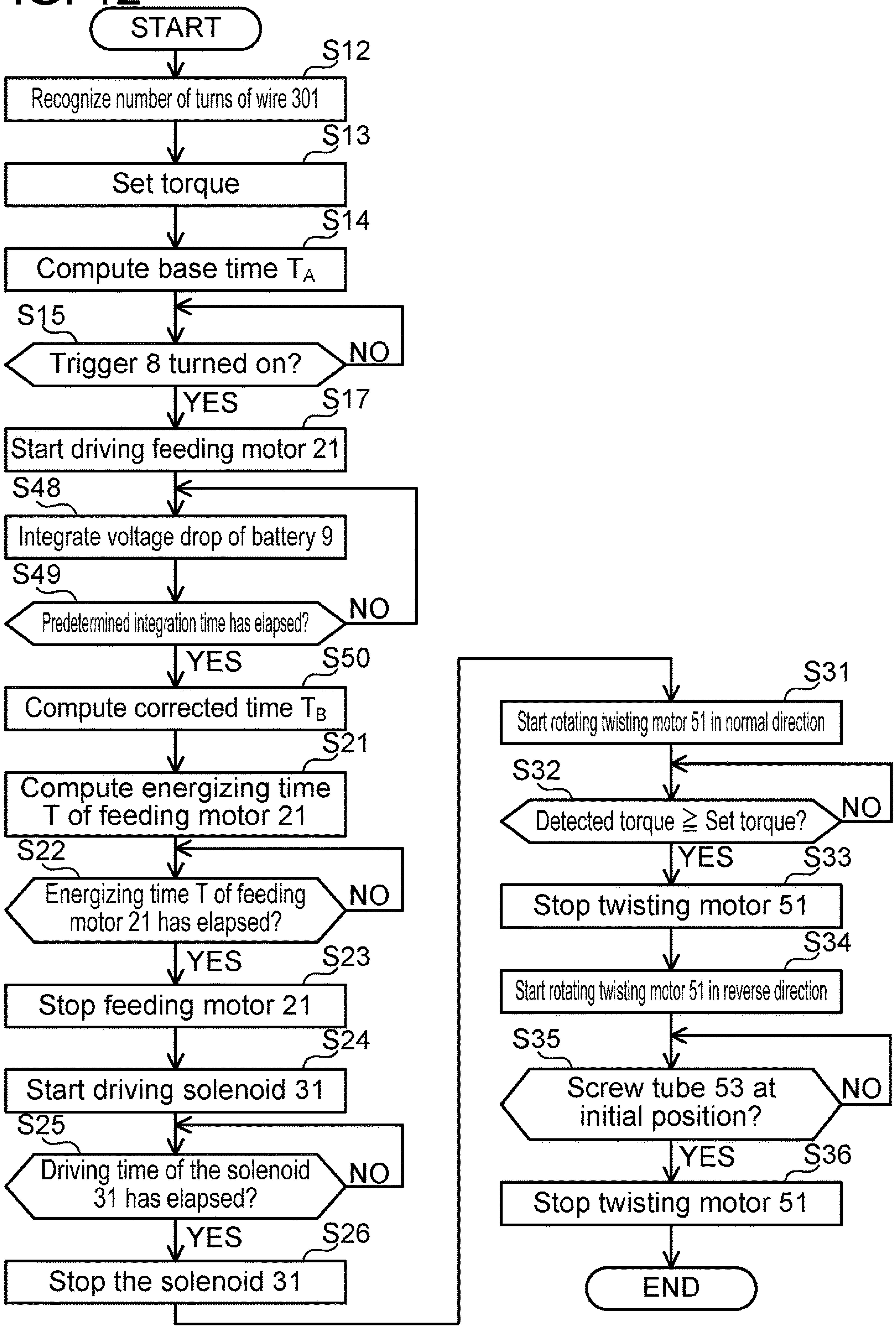

START
S12
Recognize number of turns of wire 301
S13
Set torque
S15
Trigger 8 turned on?
NO
YES
S17
Start driving feeding motor 21
S18
Integrate current that flows in feeding motor
S19
Predetermined integration time has elapsed?
NO
YES
S14
Compute base time T_A
S20
Compute corrected time T_B
S21
Compute energizing time T of feeding motor 21
S22
Energizing time T of feeding motor 21 has elapsed?
NO
YES
S23
Stop feeding motor 21
S24
Start driving solenoid 31
S25
Driving time of solenoid 31 has elapsed?
NO
YES
S26
Stop solenoid 31
S31
Start rotating twisting motor 51 in normal direction
S32
Detected torque ≧ Set torque?
NO
YES
S33
Stop twisting motor 51
S34
Start rotating twisting motor 51 in reverse direction
S35
Position of the screw tube 53 at an initial position?
NO
YES
S36
Stop twisting motor 51
END

FIG. 12


START
S12
Recognize number of turns of wire 301
S13
Set torque
S14
Compute base time T_A
S15
Trigger 8 turned on?
NO
YES
S17
Start driving feeding motor 21
S48
Integrate voltage drop of battery 9
S49
Predetermined integration time has elapsed?
NO
YES
S50
Compute corrected time T_B
S21
Compute energizing time T of feeding motor 21
S22
Energizing time T of feeding motor 21 has elapsed?
NO
YES
S23
Stop feeding motor 21
S24
Start driving solenoid 31
S25
Driving time of the solenoid 31 has elapsed?
NO
YES
S26
Stop the solenoid 31
S31
Start rotating twisting motor 51 in normal direction
S32
Detected torque ≧ Set torque?
NO
YES
S33
Stop twisting motor 51
S34
Start rotating twisting motor 51 in reverse direction
S35
Screw tube 53 at initial position?
NO
YES
S36
Stop twisting motor 51
END

REBAR TYING DEVICE

TECHNICAL FIELD

The present invention relates to a rebar tying device.

BACKGROUND ART

Patent Literature 1 (Japanese Patent No. 4548584) discloses a rebar tying device configured to tie a plurality of rebars by a wire. The rebar tying device in Patent Literature 1 includes a feeder configured to feed the wire wound around a reel by a rotation of a motor, a guide configured to guide the wire fed by the feeder around the plurality of rebars, a cutter configured to cut the wire fed by the feeder at a predetermined position, a twister configured to twist the wire around the plurality of rebars, and a control unit. Moreover, the rebar tying device in Patent Literature 1 includes a detector configured to detect a feeding length of the wire fed by the feeder. The detector includes a plurality of magnets and a Hall element. In this rebar tying device, the control unit controls a feeding length of the wire based on the feeding length of the wire detected by the detector.

SUMMARY OF INVENTION

Technical Problem

The rebar tying device in Patent Literature 1 includes the detector in order to detect the feeding length of the wire, and the detector includes the plurality of magnets and the Hall element. Therefore, a position to arrange each of the plurality of magnets and wiring of the Hall element become complicated, for example, resulting in a complicated configuration of the rebar tying device. In other words, the detector for detecting the feeding length of the wire results in a complicated configuration of the rebar tying device. Accordingly, the present disclosure provides a technology capable of feeding a wire by an accurate length without detecting a feeding length of the wire.

Solution to Technical Problem

The rebar tying device disclosed herein may be configured to tie a plurality of rebars by a wire. The rebar tying device may comprise: a feeder configured to feed the wire wound around a reel by a rotation of a feeding motor, a guide configured to guide the wire fed by the feeder around the plurality of rebars; a cutter configured to cut the wire fed by the feeder at a predetermined position; a twister configured to twist the wire around the plurality of rebars; a battery configured to supply power to the feeding motor; and a control unit. The control unit may be configured to control a feeding length of the wire by controlling an energizing time of the feeding motor based on a predetermined feeding length of the wire.

According to such a configuration, the control unit can control the feeding length of the wire by controlling the energizing time of the motor, and even without using a separate detector to detect the feeding length of the wire. Moreover, since the control unit is configured to control the energizing time of the motor based on the predetermined feeding length of the wire, the wire can be fed by an accurate length.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a perspective view of a rebar tying device according to a first embodiment;

FIG. **2** is a side view of the rebar tying device according to the first embodiment;

FIG. **3** is a diagram that schematically illustrates an internal configuration of the rebar tying device according to the first embodiment (and that corresponds to a section III-m in FIG. **1**);

FIG. **4** is a diagram that schematically illustrates the internal configuration of the rebar tying device according to the first embodiment (and that corresponds to a section IV-IV in FIG. **1**);

FIG. **5** is a diagram that schematically illustrates the internal configuration of the rebar tying device according to the first embodiment (and that corresponds to a section V-V in FIG. **1**);

FIG. **6** is a block diagram that illustrates an electrical configuration of the rebar tying device according to the first embodiment;

FIG. **7** is a flowchart that illustrates a process by a control unit according to the first embodiment;

FIG. **8** is a graph that shows a relation between a time from a start of a rotation of a feeding motor and a feeding length of a wire;

FIG. **9** is a graph that shows a relation between the time from the start of the rotation of the feeding motor and a current of the feeding motor;

FIG. **10** is a graph that shows a relation between the time from the start of the rotation of the feeding motor and a voltage of a battery;

FIG. **11** is a flowchart that illustrates a process by a control unit according to a second embodiment; and

FIG. **12** is a flowchart that illustrates a process by a control unit according to a third embodiment.

DESCRIPTION OF EMBODIMENTS

The rebar tying device according to some embodiments may comprise a setter configured to set the feeding length of the wire. The energizing time of the feeding motor may be set based on the feeding length of the wire set by the setter.

According to the configuration described above, a user of the rebar tying device can set the feeding length of the wire to a desired feeding length.

In the rebar tying device according to some embodiments, the energizing time of the feeding motor may be set based on a state of the rebar tying device before the rotation of the feeding motor.

In the rebar tying device according to some embodiments, the energizing time of the feeding motor may be set based on an open voltage of the battery before the rotation of the feeding motor.

A speed of feeding the wire by the feeding motor varies with a remaining amount of the battery. A larger remaining amount of the battery causes larger power to be supplied to the feeding motor, and a higher speed of feeding the wire. The remaining amount of the battery can be estimated from the open voltage of the battery. The open voltage of the battery means a voltage between output terminals of the battery in a state where no load is connected to the output terminals. According to the configuration described above, since the energizing time of the feeding motor is set based on the open voltage of the battery, the energizing time of the feeding motor can be controlled accurately.

In the rebar tying device according to some embodiments, the energizing time of the feeding motor may be set based on the state of the rebar tying device during the rotation of the feeding motor.

In the rebar tying device according to some embodiments, the energizing time of the feeding motor may be set based on the state of the rebar tying device when the rotation of the feeding motor is stabilized.

In the rebar tying device according to some embodiments, the energizing time of the feeding motor may be set based on the state of the feeding motor during the rotation of the feeding motor.

In the rebar tying device according to some embodiments, the energizing time of the feeding motor may be set based on an induced voltage of the feeding motor during the rotation of the feeding motor.

The speed of feeding the wire by the feeding motor varies with the induced voltage of the feeding motor, and there is a relation in which a higher induced voltage of the feeding motor causes a higher speed of feeding the wire. Accordingly, if the induced voltage of the feeding motor is low, the speed of feeding the wire is low, and hence the energizing time of the feeding motor needs to be increased. In contrast to this, if the induced voltage of the feeding motor is high, the speed of feeding the wire is high, and hence the energizing time of the feeding motor needs to be decreased. According to the configuration described above, since the energizing time of the feeding motor is set based on the induced voltage of the feeding motor when the rotation of the feeding motor is stabilized, the energizing time of the feeding motor can be controlled accurately.

In the rebar tying device according to some embodiments, the energizing time of the feeding motor may be set based on a time integration value of a current of the feeding motor during the rotation of the feeding motor.

The speed of feeding the wire by the feeding motor varies with a remaining amount of the wire wound around the reel. A larger remaining amount of the wire wound around the reel causes a larger moment of inertia of the reel, and a lower speed of feeding the wire. The remaining amount of the wire wound around the reel can be estimated based on the time integration value of the current of the feeding motor from the start of the rotation of the feeding motor. According to the configuration described above, since the energizing time of the feeding motor is set based on the time integration value of the current of the feeding motor from the start of the rotation of the feeding motor, the energizing time of the feeding motor can be controlled accurately.

In the rebar tying device according to some embodiments, the energizing time of the feeding motor may be set based on a state of the battery during the rotation of the feeding motor.

In the rebar tying device according to some embodiments, the energizing time of the feeding motor may be set based on a time integration value of a voltage drop of the battery during the rotation of the feeding motor.

The remaining amount of the wire wound around the reel can also be estimated based on the time integration value of the voltage drop of the battery from the start of the rotation of the feeding motor. According to the configuration described above, since the energizing time of the feeding motor is set based on the time integration value of the voltage drop of the feeding motor from the start of the rotation of the feeding motor, the energizing time of the feeding motor can be controlled accurately.

In the rebar tying device according to some embodiments, the energizing time of the feeding motor may be set based on a voltage of the battery during the rotation of the feeding motor.

The speed of feeding the wire by the feeding motor varies with the remaining amount of the battery. A larger remaining amount of the battery causes larger power to be supplied to the feeding motor, and a higher speed of feeding the wire. The remaining amount of the battery can be estimated from the voltage of the battery when the rotation of the feeding motor is stabilized. According to the configuration described above, since the energizing time of the feeding motor is set based on the voltage of the battery when the rotation of the feeding motor is stabilized, the energizing time of the feeding motor can be controlled accurately.

In the rebar tying device according to some embodiments may comprise a current detector configured to detect a current of the feeding motor. The current detector and the control unit may be arranged on a same substrate.

In the rebar tying device according to some embodiments may comprise a voltage detector configured to detect a voltage of the battery. The voltage detector and the control unit may be arranged on a same substrate.

Whether or not the rotation of the feeding motor is stabilized can be determined based on whether or not the current of the feeding motor is stabilized. Alternatively, whether or not the rotation of the feeding motor is stabilized can be determined based on whether or not the voltage of the battery is stabilized. Alternatively, whether or not the rotation of the feeding motor is stabilized can be determined based on whether or not a predetermined time has elapsed from the start of the rotation of the feeding motor. In this case, the rotation of the feeding motor is stabilized after the predetermined time has elapsed.

First Embodiment

A rebar tying device according to an embodiment will be described with reference to the drawings. As shown in FIGS. **1** and **2**, a rebar tying device **1** includes a first unit **11**, a second unit **12**, and a third unit **13**. The first unit **11**, the second unit **12**, and the third unit **13** are integrally formed. The rebar tying device **1** is an electrically-powered tool for tying a plurality of rebars **201** by a wire **301**. Each of the rebars **201** is a bar steel used for manufacturing, for example, a rebar-reinforced concrete.

As shown in FIGS. **3** and **4**, the first unit **11** includes a feeder **2**, a rotation regulator **3**, a guide **4**, and a twister **5**. Moreover, as shown in FIG. **5**, the first unit **11** includes a cutter **6**.

As shown in FIGS. **3** and **4**, the feeder **2** includes a reel **24**, a feeding motor **21**, a driving roller **22**, and a driven roller **23**. The feeder **2** is a mechanism that feeds the wire **301** by a rotation of the feeding motor **21**.

The reel **24** holds the wire **301**. The wire **301** is wound around the reel **24**. When the wire **301** is fed, the reel **24** rotates. The reel **24** includes a plurality of rotation-regulating protrusions **241**. Each of the plurality of rotation-regulating protrusions **241** protrudes outwardly in a radial direction of the reel **24**. The rotation-regulating protrusion **241** engages with a rotation-regulating arm **32** to be mentioned below.

The feeding motor **21** rotates by being energized. Moreover, the feeding motor **21** stops when energization is interrupted. When the feeding motor **21** rotates, the driving roller **22** rotates. The wire **301** is arranged between the driving roller **22** and the driven roller **23**. When the driving roller **22** rotates, the wire **301** is fed, and concurrently, the driven roller **23** rotates. Moreover, the reel **24** rotates by the wire **301** being fed.

The rotation regulator **3** includes a solenoid **31** and the rotation-regulating arm **32**. The rotation regulator **3** is a mechanism that regulates a rotation of the reel **24**.

The solenoid **31** operates by being energized. When the solenoid **31** operates, the rotation-regulating arm **32** operates. When the solenoid **31** is operating, the rotation-regulating arm **32** engages with the rotation-regulating protrusion **241** of the reel **24**. The rotation of the reel **24** is thereby regulated. On the other hand, when the solenoid **31** is not operating, the rotation-regulating arm **32** does not engage with the rotation-regulating protrusion **241** of the reel **24**. Regulation of the rotation of the reel **24** is thereby released.

The guide **4** includes a guide pipe **41**, an upper guide member **42**, and a lower guide member **43**. The guide **4** is a mechanism that guides the wire **301** fed by the feeder **2** to around the plurality of rebars **201**.

The guide pipe **41** is arranged at a position facing the driving roller **22** and the driven roller **23**. The guide pipe **41** guides the wire **301** fed from between the driving roller **22** and the driven roller **23** forward (in a left direction of the drawing).

The upper guide member **42** and the lower guide member **43** are arranged to face each other in a vertical direction. The upper guide member **42** is formed curvedly. The lower guide member **43** is formed linearly. A rebar arrangement region **44** is formed between the upper guide member **42** and the lower guide member **43**. The plurality of rebars **201** is arranged in the rebar arrangement region **44**. The upper guide member **42** and the lower guide member **43** guide the wire **301** guided by the guide pipe **41** around the plurality of rebars **201**. The wire **301** is thereby wound around the plurality of rebars **201**.

The twister **5** includes a twisting motor **51**, a screw shaft **52**, a screw tube **53**, and a pair of hooks **54**. The twister **5** is a mechanism that twists the wire **301** around the plurality of rebars **201**.

The twisting motor **51** rotates by being energized. Moreover, the twisting motor **51** stops when energization is interrupted. When the twisting motor **51** rotates, the screw shaft **52** rotates. The screw shaft **52** is covered with the screw tube **53**. The screw shaft **52** is threadedly engage with the screw tube **53**. When the screw shaft **52** rotates, the screw tube **53** moves in an axial direction of the screw shaft **52**. When the screw shaft **52** rotates in a normal direction, the screw tube **53** proceeds in the left direction of the drawing, and when the screw shaft **52** rotates in a reverse direction, the screw tube **53** retreats in a right direction of the drawing.

The pair of hooks **54** is coupled to the screw tube **53**. The pair of hooks **54** proceeds when the screw tube **53** proceeds in the left direction of the drawing, and the pair of hooks **54** retreats when the screw tube **53** retreats in the right direction of the drawing. The pair of hooks **54** is configured to proceed and then be coupled to the screw shaft **52**. When the screw shaft **52** rotates in a state where the pair of hooks **54** proceeds, the pair of hooks **54** rotates. Moreover, the pair of hooks **54** is configured to grasp the wire **301** when it proceeds. The pair of hooks **54** rotates while grasping the wire **301**. A rotation of the pair of hooks **54** enables the wire **301** to be twisted.

As shown in FIG. **5**, the cutter **6** includes a link mechanism **61** and a cutter portion **62**. The cutter **6** is a mechanism that cuts the wire **301** fed by the feeder **2** at a predetermined position.

The link mechanism **61** is a mechanism that converts linear motion to rotational motion and transfers the rotational motion. One end portion of the link mechanism **61** is coupled to the screw tube **53**. The other end portion of the link mechanism **61** is coupled to the cutter portion **62**. The link mechanism **61** converts linear motion of the screw tube **53** to rotational motion, and transfers the rotational motion to the cutter portion **62**. When the screw tube **53** proceeds in the left direction of the drawing, the cutter portion **62** rotates. The cutter portion **62** is configured to cut the wire **301** by rotating.

As shown in FIG. **2**, the second unit **12** includes a grip **7** and a trigger **8**. The grip **7** is a portion grasped by a user. The trigger **8** is arranged above the grip **7**. A user depresses the trigger **8** while grasping the grip **7**. The rebar tying device **1** is configured to operate when the trigger **8** is depressed.

The third unit **13** includes a battery **9** and a dial **10** (an example of the setter). The battery **9** supplies power to each of the feeding motor **21**, the twisting motor **51**, and the solenoid **31**. The battery **9** is configured to be detachably attached.

The dial **10** is a configuration for setting a number of turns of the wire **301**. A user can set the number of turns of the wire **301** by turning the dial **10**. For example, if the number of turns of the wire **301** is to be set to two, the dial is tuned to "2". Moreover, when the number of turns of the wire **301** is set, a torque by which the wire **301** is twisted is set accordingly. Moreover, when the number of turns of the wire **301** is set, a feeding length of the wire **301** is determined accordingly. The dial **10** is arranged on a substrate **112**. The substrate **112** is arranged above the battery **9**.

As shown in FIG. **6**, the rebar tying device **1** further includes a control unit **101** (an example of the control unit), a current sensor **75** (an example of the current detector), a voltage sensor **76** (an example of the voltage detector), a torque sensor **77**, and a position sensor **78**. Moreover, the rebar tying device **1** includes a plurality of drivers **85**, **86**, and **87**, and a regulator **79**.

The control unit **101**, the current sensor **75**, the voltage sensor **76**, the torque sensor **77**, and the position sensor **78** are arranged in the first unit **11**. The control unit **101**, the current sensor **75**, and the voltage sensor **76** are arranged on a same substrate **111**. The substrate **111** is arranged below the feeding motor **21** and the twisting motor **51**. The current sensor **75** is configured to detect a current of the feeding motor **21**. The torque sensor **77** is configured to detect a torque that acts on the twisting motor **51** when the pair of hooks **54** is rotating. The position sensor **78** is configured to detect a position of the screw tube **53**. The voltage sensor **76** is configured to detect a voltage of the battery **9**. Each of the current sensor **75**, the voltage sensor **76**, the torque sensor **77**, and the position sensor **78** transmits a signal to the control unit **101**.

The plurality of drivers **85**, **86**, and **87**, and the regulator **79** are arranged in the first unit **11**. The plurality of drivers **85**, **86**, and **87**, and the regulator **79** are arranged on the same substrate **111**. A signal is transmitted from the control unit **101** to the feeding motor **21** via the driver **85**. Moreover, a signal is transmitted from the control unit **101** to the twisting motor **51** via the driver **86**. Moreover, a signal is transmitted from the control unit portion **101** to the solenoid **31** via the driver **87**. Moreover, the regulator **79** adjusts a voltage of the power supplied by the battery **9** and then supplied the power to the control unit **101**.

The control unit **101** controls an energizing time of the feeding motor **21** based on a preset feeding length of the wire **301**. The control unit **101** controls a feeding length of the wire **301** by controlling the energizing time of the feeding motor **21**. An operation of the control unit **101** will be described later in details. The control unit **101** is arranged on a substrate (not shown) in the first unit **11**.

The control unit **101** includes a memory **102**. The memory **102** stores a program executed by the control unit **101**. The memory **102** stores various types of information.

Next, an operation of the rebar tying device **1** will be described. When a user uses the rebar tying device **1**, the user initially turns the dial **10** to set the number of turns of the wire **301**. Next, the user arranges the rebar tying device **1** with respect to the plurality of rebars **201**. Specifically, as shown in FIG. **1**, the user grasps the rebar tying device **1** such that the plurality of rebars **201** are positioned in the rebar arrangement region **44**. Successively, the user depresses the trigger **8** while grasping the grip **7**.

When the trigger **8** is depressed, the wire **301** is fed by the feeder **2**, and the fed wire **301** is guided by the guide **4** to around the plurality of rebars **201**. The wire **301** is thereby wound around the plurality of rebars **201**. The wire **301** fed by the feeder **2** is cut by the cutter **6** at a predetermined position. Moreover, the wire **301** wound around the plurality of rebars **201** is twisted by the twister **5**. The plurality of rebars **201** is thereby tied by the wire **301**.

Next, the operation of the control unit **101** will be described. When the rebar tying device **1** ties the plurality of rebars **201**, the control unit **101** executes the following process based on the program.

When the user sets the number of turns of the wire **301** as described above, the control unit **101** recognizes the set number of turns of the wire **301** in S12 in FIG. **7**. The number of turns of the wire **301** determines a feeding length of the wire **301**. Moreover, the number of turns of the wire **301** determines a provisional energizing time of the feeding motor **21**. This provisional energizing time is corrected in S14 and the following steps mentioned below.

In the next S13, the control unit **101** sets a torque that corresponds to the set number of turns of the wire **301**. The set torque is used when the wire **301** wound around the plurality of rebars **201** is twisted.

In the next S14, the control unit **101** computes a base time T_A. The base time T_A is computed based on a first coefficient K_1 and an open voltage V_{open} of the battery **9**. The base time T_A is represented by Equation 1. A higher open voltage V_{open} of the battery **9** causes a shorter base time T_A. In contrast to this, a lower open voltage V_{open} of the battery **9** causes a longer base time T_A.

[Math. 1]

$$T_A = \frac{K_1}{V_{OPEN}} \quad \text{(Eq. 1)}$$

T_A: Base time

K_1: First coefficient

V_{OPEN}: Open voltage of battery

The first coefficient K_1 is preset in accordance with the number of turns of the wire **301**, and prestored in the memory **102**. The first coefficient K_1 is empirically determined in advance. The open voltage V_{open} of the battery **9** refers to a voltage between output terminals of the battery **9** in a state where the feeding motor **21**, the solenoid **31**, and the twisting motor **51** are not driven, or in a state where no power is supplied from the battery **9** to the feeding motor **21**, the solenoid **31**, and the twisting motor **51**. The open voltage V_{open} of the battery **9** is measured before the feeding motor **21**, the solenoid **31**, and the twisting motor **51** are driven, and stored in the memory **102**. The base time T_A is used for computing the energizing time of the feeding motor **21**.

In the next S**15**, the control unit **101** determines whether or not the trigger **8** is turned on. If the user depresses the trigger **8**, the trigger **8** is turned on. If the trigger **8** is turned on in S**15**, the control unit **101** makes a determination of YES and proceeds to S17. On the other hand, if the trigger **8** is not turned on (is turned off) in S**15**, the control unit **101** makes a determination of NO and waits.

In the next S17, the control unit **101** starts driving the feeding motor **21**. The feeding motor **21** thereby rotates. When the feeding motor **21** rotates, the driving roller **22** rotates, and the wire **301** wound around the reel **24** is fed. The wire **301** fed by the rotation of the feeding motor **21** is guided by the guide **4** to around the plurality of rebars **201**. As shown in FIG. **8**, when the feeding motor **21** rotates and the wire **301** is fed, the feeding length of the wire **301** increases with a lapse of time.

Moreover, as shown in FIG. **9**, when the feeding motor **21** starts rotating, a current that flows in the feeding motor **21** varies with a lapse of time. The current of the feeding motor **21** is detected by the current sensor **75**. Until a certain time has elapsed from the start of the rotation of the feeding motor **21**, the feeding motor **21** has a high load imposed thereon in order to start rotating the reel **24** in a stopped state, and the current of the feeding motor **21** becomes unstable and large. In other words, during this period, the rotation of the feeding motor **21** can be said to be unstable. On the other hand, after the certain time has elapsed from the start of the rotation of the feeding motor **21**, the reel **24** continues rotating stably, and hence the load imposed on the feeding motor **21** becomes low, and the current of the feeding motor **21** becomes stable and small. In other words, during this period, the rotation of the feeding motor **21** can be said to be stabilized.

Moreover, as shown in FIG. **10**, when the feeding motor **21** starts rotating, a voltage of the battery **9** varies with a lapse of time. The voltage of the battery **9** is detected by the voltage sensor **76**. Until a certain time has elapsed from the start of the rotation of the feeding motor **21**, the voltage of the battery **9** is unstable. On the other hand, after the certain time has elapsed from the start of the rotation of the feeding motor **21**, the voltage of the battery **9** is stabilized.

When the feeding motor **21** rotates and the wire **301** is fed, the control unit **101** integrates the current that flows in the feeding motor **21** in the next S18 until the rotation of the feeding motor **21** is stabilized from the start of the rotation of the feeding motor **21**. In the present embodiment, the control unit **101** integrates the current of the feeding motor **21** for a predetermined integration time after the start of the rotation of the feeding motor **21**. The integration time is preset in consideration of a time required for the rotation of the feeding motor **21** to be stabilized. For example, the integration time is set to 0.1 seconds. In S**18**, a time integration value I_{sum} of the current of the feeding motor **21** is computed.

In the next S19, the control unit **101** determines whether or not the predetermined integration time has elapsed from the start of the rotation of the feeding motor **21**. If the predetermined integration time has elapsed in S19, the control unit **101** makes a determination of YES and proceeds to S**20**. If the predetermined integration time has elapsed, the rotation of the feeding motor **21** has already been stabilized. On the other hand, if the predetermined integration time has not elapsed yet in S19, the control unit **101** makes a determination of NO and returns to S**18**, and continues integrating the current of the feeding motor **21**.

In S**20**, the control unit **101** computes a corrected time T_B. The corrected time T_B is computed based on a second coefficient K_2, the time integration value I_{sum} of the current of the feeding motor **21**, a current I of the feeding motor **21** when the rotation of the feeding motor **21** is stabilized (i.e., the current I of the feeding motor **21** after the predetermined integration time has elapsed from the start of the rotation of the feeding motor **21**), a voltage V_{max} of the battery **9** when the battery **9** is fully charged, and a voltage V_b of the battery **9** when the rotation of the feeding motor **21** is stabilized (i.e., the voltage V_b of the battery **9** after the predetermined integration time has elapsed from the start of the rotation of the feeding motor **21**). The corrected time T_B is represented by Equation 2.

[Math. 2]

$$T_B = K_2 \times \frac{I_{sum}}{I} \times \frac{V_{MAX}}{V_b} \quad \text{(Eq. 2)}$$

T_B: Corrected time
K_2: Second coefficient
I_{sum}: Time integration value of current of feeding motor
I: Current of feeding motor when rotation of feeding motor is stabilized
V_{MAX}: Voltage of battery when battery is fully charged
V_b: Voltage of battery when rotation of feeding motor is stabilized

The second coefficient K_2 is preset, and prestored in the memory **102**. The second coefficient K_2 is empirically determined in advance. The voltage V_{max} of the battery **9** when the battery **9** is fully charged is determined in advance for every product, and prestored in the memory **102**. The corrected time T_B is used for computing the energizing time of the feeding motor **21**.

In the next S**21**, the control unit **101** computes an energizing time T of the feeding motor **21** based on the base time T_A and the corrected time T_B. The energizing time T of the feeding motor **21** is represented by Equation 3.

[Math. 3]

$$T=T_A+T_B \quad \text{(Eq.3)}$$

T: Energizing time of feeding motor

In the next S**22**, the control unit **101** determines whether or not the energizing time T of the feeding motor **21** computed in S**21** has elapsed from the start of the rotation of the feeding motor **21**. If the energizing time T of the feeding motor **21** has elapsed in S**22**, the control unit **101** makes a determination of YES and proceeds to S**23**. On the other hand, if the energizing time T of the feeding motor **21** has not elapsed in S**22**, the control unit **101** makes a determination of NO and waits.

In S**23**, the control unit **101** stops the feeding motor **21**. When the feeding motor **21** stops, the driving roller **22** stops and the wire **301** is no longer fed. An operation of feeding the wire **301** is thereby terminated.

In S**24**, the control unit **101** starts driving the solenoid **31**. This causes the solenoid **31** and the rotation-regulating arm **32** to operate. When the rotation-regulating arm **32** operates, the rotation-regulating arm **32** engages with the rotation-regulating protrusion **241** of the reel **24**. The rotation of the reel **24** is thereby regulated.

In the next S**25**, the control unit **101** determines whether or not a driving time of the solenoid **31** (e.g., 45 ms) has elapsed. If the driving time of the solenoid **31** has elapsed in S**25**, the control unit **101** makes a determination of YES and proceeds to S**26**. On the other hand, if the driving time of the solenoid **31** has not elapsed in S**25**, the control unit makes a determination of NO and continues operating.

In S**26**, the control unit **101** stops the solenoid **31**. When the solenoid **31** stops, the rotation-regulating arm **32** and the rotation-regulating protrusion **241** of the reel **24** are disengaged from each other, and the regulation of the rotation of the reel **24** is released.

In the next S**31**, the control unit **101** starts rotating the twisting motor **51** of the twister **5** in a normal direction. When the twisting motor **51** rotates in the normal direction, the screw shaft **52** rotates in the normal direction, and the screw tube **53** proceeds accordingly.

When the screw tube **53** proceeds, the link mechanism **61** of the cutter **6** converts linear motion to rotational motion, and the cutter portion **62** rotates. When the cutter portion **62** rotates, the wire **301** is cut by the cutter portion **62**.

Moreover, when the screw tube **53** proceeds, the pair of hooks **54** proceeds. At a position where the pair of hooks **54** proceeds, the pair of hooks **54** grasps the wire **301** around the plurality of rebars **201**. Moreover, while grasping the wire **301**, the pair of hooks **54** rotates by a rotation of the screw shaft **52**. When the pair of hooks **54** rotates, the wire **301** is twisted. When the wire **301** is twisted, a torque that acts on the screw shaft **52** increases, and a torque of the twisting motor **51** increases. The torque that acts on the twisting motor **51** is detected by the torque sensor **77** detecting the current of the twisting motor **51**.

In the next S**32**, the control unit **101** determines whether or not the torque detected by the torque sensor **77** is equal to or above the torque set in S**13** described above. If the detected torque is equal to or above the set torque, the control unit **101** makes a determination of YES in S**32** and proceeds to S**33**. On the other hand, if the detected torque is not equal to or above (is less than) the set torque, the control unit **101** makes a determination of NO in S**32** and waits.

In S**33**, the control unit **101** stops the twisting motor **51**.

In the next S**34**, the control unit **101** starts rotating the twisting motor **51** in a reverse direction. When the twisting motor **51** rotates in the reverse direction, the pair of hooks **54** releases the wire **301** that they grasp. After the pair of hooks **54** releases the wire **301**, the screw shaft **52** rotates in a reverse direction, and the screw tube **53** retreats accordingly. The position of the screw tube **53** is detected by the position sensor **78**. When the screw tube **53** retreats, the pair of hooks **54** retreats.

In the next S**35**, the control unit **101** determines whether or not the position of the screw tube **53** detected by the position sensor **78** is an initial position. If the position of the screw tube **53** is the initial position at S**35**, the control unit **101** makes a determination of YES and proceeds to S**36**. On the other hand, if the position of the screw tube **53** is not the initial position at S**35**, the control unit **101** makes a determination of NO and continues operating.

In S**36**, the control unit **101** stops the twisting motor **51**. The twisting operation of the wire **301** is thereby terminated. As described above, the rebar tying device **1** ties the plurality of rebars **201** by the wire **301**.

As described above, the configuration and the operation of the rebar tying device **1** in the first embodiment have been described. As is clear from the description above, the rebar tying device **1** in the present embodiment includes the feeder **2** configured to feed the wire **301** wound around the reel **24** by the rotation of the feeding motor **21**, the guide **4** configured to guide the wire **301** fed by the feeder **2** to around the plurality of rebars **201**, and the cutter **6** configured to cut the wire **301** fed by the feeder **2** at a predetermined position. Moreover, the rebar tying device **1** includes the twister **5** configured to twist the wire **301** around the plurality of rebars **201**, the battery **9** configured to supply power to the feeding motor **21**, and the control unit **101**. Moreover, as shown in Expression 1, the control unit **101** computes the base time T_A based on the first coefficient K_1 that corresponds to the number of turns of the wire **301** set by the dial **10**. As shown in Equation 3, the control unit **101** then computes the energizing time T of the feeding motor **21** based on the base time T_A. Moreover, as shown in FIG. **7**, if the computed energizing time T of the feeding motor **21** has elapsed, the control unit **101** stops the feeding motor **21**. As such, the control unit **101** controls the feeding length of the wire **301** by controlling the energizing time T of the feeding motor **21** based on the preset feeding length of the wire **301**.

According to such a configuration, since the control unit **101** can control the feeding length of the wire **301** by controlling the energizing time T of the feeding motor **21**, the control unit **101** can control the feeding length of the wire **301** without using a separate detector to detect the feeding length of the wire **301**. Moreover, since the control unit **101** controls the energizing time T of the feeding motor **21** based on the preset feeding length of the wire **301**, the wire **301** can be fed by an accurate length.

Moreover, in the embodiment described above, the base time T_A is computed based on the open voltage V_{open} of the battery **9** as shown in Equation 1, and the energizing time T of the feeding motor **21** is computed based on the base time T_A as shown in Expression 3. As such, the energizing time T of the feeding motor **21** is set based on the open voltage V_{open} of the battery **9**. The energizing time T of the feeding motor **21** is set based on a state of the rebar tying device **1** before the rotation of the feeding motor **21**. The speed of feeding the wire **301** by the feeding motor **21** depends on the open voltage V_{open} of the battery **9**, and a higher open voltage V_{open} of the battery **9** causes a higher speed of feeding the wire **301**, and hence the energizing time T of the feeding motor **21** needs to be decreased. In contrast to this, a lower open voltage V_{open} of the battery **9** causes a lower speed of feeding the wire **301**, and hence the energizing time T of the feeding motor **21** needs to be increased. According to the configuration described above, since the energizing time T of the feeding motor **21** is set based on the open voltage V_{open} of the battery **9**, the energizing time T of the feeding motor **21** can be controlled accurately.

Moreover, in the embodiment described above, the corrected time T_B is computed based on the time integration value I_{sum} of the current of the feeding motor **21** as shown in Equation 2, and the energizing time T of the feeding motor **21** is computed based on the corrected time T_B as shown in Equation 3. As such, the energizing time T of the feeding motor **21** is set based on the time integration value I_{sum} of the current of the feeding motor **21** from the start of the rotation of the feeding motor **21**. In other words, the energizing time T of the feeding motor **21** is set based on the state of the rebar tying device **1** during the rotation of the feeding motor **21**. Moreover, the energizing time T of the feeding motor **21** is set based on the state of the feeding motor **21**. The speed of feeding the wire **301** by the feeding motor **21** varies with the remaining amount of the wire **301** wound around the reel **24**, and a larger remaining amount of the wire **301** wound around the reel **24** causes a larger moment of inertia of the reel **24**, and a lower speed of feeding the wire **301**. The remaining amount of the wire **301** wound around the reel **24** can be estimated based on the time integration value I_{sum} of the current of the feeding motor **21** from the start of the rotation of the feeding motor **21**. According to the configuration described above, since the energizing time T of the feeding motor **21** is set based on the time integration value I_{sum} of the current of the feeding motor **21** from the start of the rotation of the feeding motor **21**, the energizing time T of the feeding motor **21** can be controlled accurately. The corrected time T_B is preferably computed at an early timing after the rotation of the feeding motor **21** is stabilized. A sufficient time for computing the corrected time T_B can thereby be ensured.

Moreover, in the embodiment described above, the corrected time T_B is computed based on the voltage V_b of the battery **9** when the rotation of the feeding motor **21** is stabilized as shown in Equation 2, and the energizing time T of the feeding motor **21** is computed based on the corrected time T_B as shown in Equation 3. In other words, the energizing time T of the feeding motor **21** is set based on the state of the rebar tying device **1** when the rotation of the feeding motor **21** is stabilized. The energizing time T of the feeding motor **21** is set based on the state of the battery **9**. The energizing time T of the feeding motor **21** is set based on the voltage V_b of the battery **9** when the rotation of the feeding motor **21** is stabilized. The speed of feeding the wire **301** by the feeding motor **21** varies with the remaining amount of the battery **9**, and a larger remaining amount of the battery **9** causes larger power to be supplied to the feeding motor **21**, and a higher speed of feeding the wire **301**. The remaining amount of the battery **9** can be estimated from the voltage V_b of the battery **9** when the rotation of the feeding motor **21** is stabilized. According to the configuration described above, since the energizing time T of the feeding motor **21** is set based on the voltage V_b of the battery **9** when the rotation of the feeding motor **21** is stabilized, the energizing time T of the feeding motor **21** can be controlled accurately.

Moreover, in the embodiment described above, the rebar tying device **1** includes the dial **10** configured to set the feeding length of the wire **301**, and the energizing time T of the feeding motor **21** is set based on the feeding length of the wire **301** set by the dial **10**. According to such a configuration, a user of the rebar tying device **1** can set the feeding length of the wire **301** to a desired feeding length.

One embodiment has been described above. However, a specific aspect is not limited to the embodiment described above. It should be noted that, in the following description, a configuration similar to the configuration in the description mentioned above has the same sign attached thereto, and a description thereof will be omitted.

Second Embodiment

In the embodiment described above, the base time T_A is computed based on the open voltage V_{open} of the battery **9** as shown in Equation 1. However, the configuration of the present teachings is not limited thereto. Moreover, in the embodiment described above, the base time T_A is computed before the rotation of the feeding motor **21**. However, the configuration of the present teachings is not limited thereto. In a second embodiment, as shown in FIG. 11, the control unit **101** sets a torque in S**13**, and then proceeds to S**15** without computing the base time T_A.

Subsequently, when the control unit **101** makes a determination of YES in S**19**, the control unit **101** proceeds to S**14**. In S**14**, the control unit **101** computes the base time T_A. The base time T_A is computed during the rotation of the feeding motor **21**. The base time T_A is computed as follows. In other words, the control unit **101** initially computes an induced voltage E_M of the feeding motor **21** based on an applied voltage V_M of the feeding motor **21** and a current I of the feeding motor **21** when the rotation of the feeding motor **21** is stabilized (i.e., the applied voltage V_M of the feeding motor **21** and the current I of the feeding motor **21** after a predetermined time has elapsed from the start of the rotation of the feeding motor **21**), and a resistance R_M of the feeding motor **21**. The induced voltage E_M of the feeding motor **21** is represented by Equation 4. It should be noted that, when the induced voltage E_M of the feeding motor **21** is to be computed, an influence by an inductor of the feeding motor **21** is negligible.

[Math. 4]

$$E_M = V_M - I \times R_M \quad \text{(Eq. 4)}$$

E_M: Induced voltage of feeding motor
V_M: Applied voltage of feeding motor
I: Current of feeding motor when rotation of feeding motor is stabilized
R_M: Resistance of feeding motor

Next, the control unit **101** computes a speed SPD of feeding the wire **301** based on a third coefficient K_3 and the induced voltage E_M of the feeding motor **21**. The speed SPD of feeding the wire **301** can be represented by Equation 5. The third coefficient K_3 is empirically determined in advance, and prestored in the memory **102**.

[Math. 5]

$$\mathrm{SPD} = K_3 \times E_M \quad \text{(Eq.5)}$$

SPD: Speed of feeding wire
K_3: Third coefficient
E_M: Induced voltage of feeding motor

Next, the control unit **101** computes the base time T_A based on a preset feeding length L of the wire **301** and the speed SPD of feeding the wire **301**. The base time T_A is represented by Equation 6.

[Math. 6]

$$T_A = \frac{L}{SPD} \quad \text{(Eq. 6)}$$

T_A: Base time
SPD: Speed of feeding wire
L: Preset feeding length of wire

The feeding length L of the wire **301** is set in accordance with the number of turns of the wire **301** set by the dial **10**. A correspondence between the feeding length L of the wire **301** and the number of turns of the wire **301** is preset, and prestored in the memory **102**.

In the second embodiment, as shown in Equations 4 to 6, the base time T_A is computed based on the induced voltage E_M of the feeding motor **21**. As shown in Equation 3, the energizing time T of the feeding motor **21** is then computed based on the base time T_A and the corrected time T_B. As such, the energizing time T of the feeding motor **21** is set based on the induced voltage E_M of the feeding motor **21** when the rotation of the feeding motor **21** is stabilized. The speed of feeding the wire **301** by the feeding motor **21** is proportional to the induced voltage E_M of the feeding motor **21**. Accordingly, if the induced voltage E_M of the feeding motor **21** is low, the speed of feeding the wire **301** is low, and hence the energizing time T of the feeding motor **21** needs to be increased. In contrast to this, if the induced voltage E_M of the feeding motor **21** is high, the speed of feeding the wire **301** is high, and hence the energizing time T of the feeding motor **21** needs to be decreased. According to the configuration described above, since the energizing time T of the feeding motor **21** is set based on the induced voltage E_M of the feeding motor **21** when the rotation of the feeding motor **21** is stabilized, the energizing time T of the feeding motor **21** can be controlled accurately.

Third Embodiment

Although, in the embodiments described above, the control unit **101** integrates the current of the feeding motor **21** in S**18**, the configuration of the present teachings is not limited thereto. Moreover, as shown in Equation 2, the corrected time T_B is computed based on the time integration value I_{sum} of the current of the feeding motor **21**. However, the configuration of the present teachings is not limited thereto. In a third embodiment, as shown in FIG. **12**, after the control unit **101** starts driving the feeding motor **21** in S**17**, the control unit **101** integrates a voltage drop ΔV of the battery **9** in the next S**48** until the rotation of the feeding motor **21** is stabilized from the start of the rotation of the feeding motor **21**. In other words, the voltage drop ΔV of the battery **9** is integrated for the predetermined integration time from the start of the rotation of the feeding motor **21**. A time integration value ΔV_{sum} of the voltage drop ΔV of the battery **9** is thereby obtained. The integration time is preset in consideration of a time required for the rotation of the feeding motor **21** to be stabilized. For example, the integration time is set to 0.1 seconds.

The voltage drop ΔV of the battery **9** is a difference between the open voltage V_{open} of the battery **9** and the voltage of the battery **9** when the feeding motor **21** is rotating. In other words, the voltage drop ΔV of the battery **9** is an amount of a voltage drop of the battery **9** from the open voltage V_{open} of the battery **9**. As shown in FIG. **10**, the voltage drop ΔV of the battery **9** is increasing until a certain time has elapsed from the start of the rotation of the feeding motor **21**. On the other hand, the voltage drop ΔV of the battery **9** is decreasing after the certain time has elapsed from the start of the rotation of the feeding motor **21**.

In the next S**49**, the control unit **101** determines whether or not the predetermined integration time has elapsed from the start of the rotation of the feeding motor **21**. If the predetermined integration time elapses in S**49**, the control unit **101** makes a determination of YES and proceeds to S**50**. If the predetermined integration time has elapsed, the rotation of the feeding motor **21** is stabilized. On the other hand, if the predetermined integration time has not elapsed in S**49**, the control unit **101** makes a determination of NO and continues integrating the voltage drop ΔV of the battery **9**.

In S**50**, the control unit **101** computes the corrected time T_B. The corrected time T_B is computed based on a fourth coefficient K_4, the time integration value ΔV_{sum} of the voltage drop ΔV of the battery **9**, the voltage drop ΔV of the battery **9** when the rotation of the feeding motor **21** is stabilized (i.e., the voltage drop ΔV of the battery **9** after the predetermined integration time has elapsed from the start of the rotation of the feeding motor **21**), the voltage V_{max} of the battery **9** when the battery **9** is fully charged, and the voltage V_b of the battery **9** when the rotation of the feeding motor **21** is stabilized (i.e., the voltage V_b of the battery **9** after the predetermined integration time has elapsed from the start of the rotation of the feeding motor **21**). The corrected time T_B is represented by Equation 7.

[Math. 7]

$$T_B = K_4 \times \frac{\Delta V_{sum}}{\Delta V} \times \frac{V_{MAX}}{V_b} \quad \text{(Eq. 7)}$$

T_B: Corrected time
K_4: Fourth coefficient
ΔV_{sum}: Time integration value of voltage drop of battery
ΔV: Voltage drop of battery when rotation of the feeding motor is stabilized
V_{MAX}: Voltage of battery when battery is fully charged
V_b: Voltage of motor after predetermined time has elapsed

The fourth coefficient K_4 is preset, and prestored in the memory **102**. The fourth coefficient K_4 is empirically determined in advance.

In the third embodiment, the corrected time T_B is computed based on the time integration value ΔV_{sum} of the voltage drop ΔV of the battery **9** as shown in Equation 7, and the energizing time T of the feeding motor **21** is computed based on the corrected time T_B as shown in Equation 3. As such, the energizing time T of the feeding motor **21** is set based on the time integration value ΔV_{sum} of the voltage drop ΔV of the battery **9** from the start of the rotation of the feeding motor **21**. The speed of feeding the wire **301** by the feeding motor **21** varies with the remaining amount of the wire **301** wound around the reel **24**, and a larger remaining amount of the wire **301** wound around the reel **24** causes a larger moment of inertia of the reel **24** and a lower speed of feeding the wire **301**. The remaining amount of the wire **301** wound around the reel **24** can be estimated based on the time integration value ΔV_{sum} of the voltage drop ΔV of the battery **9** from the start of the rotation of the feeding motor **21**. According to the configuration described above, since the energizing time T of the feeding motor **21** is set based on the time integration value ΔV_{sum}, of the voltage drop ΔV of the feeding motor **21** from the start of the rotation of the feeding motor **21**, the energizing time T of the feeding motor **21** can be controlled accurately.

Moreover, a specific aspect is not limited to the embodiment described above. In the embodiment described above, the base time T_A is computed based on Expression 1. However, computing the base time T_A is not limited to this configuration. For example, the base time T_A may be configured to vary stepwisely with the open voltage V_{open} of the battery **9**. For example, if the open voltage V_{open} of the battery **9** is equal to or above a predetermined threshold value, the base time T_A may be set as follows: $T_A=T_{A1}$ (a constant), and if the open voltage V_{open} of the battery **9** is less than the predetermined threshold value, the base time T_A may be set as follows: $T_A=T_{A2}$ (a constant). It should be noted that, $T_{A1}<T_{A2}$. With such a configuration as well, the base time T_A in the energizing time T of the feeding motor **21** can be set based on the open voltage V_{open} of the battery **9**.

Moreover, in the embodiments described above, the corrected time T_B is computed based on Equations 2 or 7. However, computing the corrected time T_B is not limited to this configuration. For example, the corrected time T_B may also be configured to vary stepwisely with the time integration value I_{sum} of the current of the feeding motor **21**. Alternatively, the corrected time T_B may also be configured to vary stepwisely with the time integration value ΔV_{sum} of the voltage drop ΔV of the battery **9**. Alternatively, the corrected time T_B may also be configured to vary stepwisely with the voltage V_b of the battery **9** when the rotation of the feeding motor **21** is stabilized.

For example, if the time integration value I_{sum} of the current of the feeding motor **21** is equal to or above a predetermined threshold value, the corrected time T_B may be set as follows: $T_B=T_{B1}$ (a constant), and if the time integration value I_{sum} of the current of the feeding motor **21** is less than the predetermined threshold value, the corrected time T_B may be set as follows: $T_B=T_{B2}$ (a constant). It should be noted that, $T_{B1}>T_{B2}$. With such a configuration as well, the corrected time T_B in the energizing time T of the feeding motor **21** can be set based on the time integration value I_{sum} of the current of the feeding motor **21**.

Alternatively, if the time integration value ΔV_{sum} of the voltage drop ΔV of the battery **9** is equal to or above a predetermined threshold value, the corrected time T_B may be set as follows: $T_B=T_{B3}$ (a constant), and if the time integration value ΔV_{sum} of the voltage drop ΔV of the battery **9** is less than the predetermined threshold value, the corrected time T_B may be set as follows: $T_B=T_{B4}$ (a constant). It should be noted that, $T_{B3}>T_{B4}$. With such a configuration as well, the corrected time T_B in the energizing time T of the feeding motor **21** can be set based on the time integration value ΔV_{sum} of the voltage drop ΔV of the battery **9**.

Alternatively, if the voltage V_b of the battery **9** when the rotation of the feeding motor **21** is stabilized is equal to or above a predetermined threshold value, the corrected time T_B may be set as follows: $T_B=T_BS$ (a constant), and if the voltage V_b of the battery **9** when the rotation of the feeding motor **21** is stabilized is less than the predetermined threshold value, the corrected time T_B may be set as follows: $T_B=T_{B6}$ (a constant). It should be noted that, $T_{B5}<T_{B6}$. With such a configuration as well, the corrected time T_B in the energizing time T of the feeding motor **21** can be set based on the voltage V_b of the battery **9** when the rotation of the feeding motor **21** is stabilized.

Moreover, in the embodiments described above, the control unit **101** is arranged on the substrate **1** in the first unit **11**. However, the position of the control unit **101** is not particularly limited. For example, the control unit **101** may also be arranged on a substrate in the second unit **12** or a substrate in the third unit **13** (both of them are not shown). Moreover, a function of the control unit **101** may be provided in a distributed manner to a plurality of substrates.

Moreover, although in the embodiments described above, the torque sensor **77** is configured to detect a torque that acts on the twisting motor **51**, the configuration of the present disclosure is not limited thereto. In another embodiment, the current sensor **75** may be configured to detect a current of the twisting motor **51**, in addition to a current of the feeding motor **21**. The current sensor **75** is configured to detect the torque that acts on the twisting motor **51** by detecting the current of the twisting motor **51**.

Specific examples of the present invention have been described in detail, however, these are mere exemplary indications and thus do not limit the scope of the claims. The art described in the claims includes modifications and variations of the specific examples presented above. Technical features described in the description and the drawings may technically be useful alone or in various combinations, and are not limited to the combinations as originally claimed. Further, the art described in the description and the drawings may concurrently achieve a plurality of aims, and technical significance thereof resides in achieving any one of such aims.

REFERENCE SIGNS LIST

1: rebar tying device, **2**: feeder, **3**: rotation regulator, **4**: guide, **5**: twister, **6**: cutter, **7**: grip, **8**: trigger, **9**: battery, **10**:

dial, **11**: first unit, **12**: second unit, **13**: third unit, **21**: feeding motor, **22**: driving roller, **23**: driven roller, **24**: reel, **31**: solenoid, **32**: rotation-regulating arm, **41**: guide pipe, **42**: upper guide member, **43**: lower guide member, **44**: rebar arrangement region, **51**: twisting motor, **52**: screw shaft, **53**: screw tube, **54**: hook, **61**: link mechanism, **62**: cutter portion, **75**: current sensor, **76**: voltage sensor, **77**: torque sensor, **78**: position sensor, **79**: regulator, **85**: driver, **86**: driver, **87**: driver, **101**: control unit, **102**: memory, **111**: substrate, **112**: substrate, **201**: rebar, **241**: rotation-regulating protrusion, **301**: wire.

The invention claimed is:

1. A rebar tying device that ties a plurality of rebars by a wire, the device comprising:
- a feeder that feeds the wire wound around a reel by a rotation of a feeding motor;
- a guide that guides the wire fed by the feeder around the plurality of rebars;
- a cutter that cuts the wire fed by the feeder;
- a twister that twists the wire around the plurality of rebars;
- a battery that supplies power to the feeding motor;
- a control unit including a memory; and
- a current detector that detects a current of the feeding motor,
- wherein the memory stores a program executed by the control unit to cause the control unit to:
- determine an energizing time of the feeding motor based on a time integration value of the current of the feeding motor during rotation of the feeding motor, and
- control a feeding length of the wire by energizing the feeding motor for the determined energizing time.

2. The rebar tying device according to claim **1**,
- wherein the program stored in the memory causes the control unit to:
- integrate a value of the current of the feeding motor over time during the rotation of the feeding motor to determine a time integration value of the current of the feeding motor during the rotation of the feeding motor,
- determine an energizing time of the feeding motor based on the determined time integration value of the current of the feeding motor during the rotation of the feeding motor.

3. The rebar tying device according to claim **1**, further comprising:
- a voltage detector that detects a voltage of the battery,
- wherein the program stored in the memory causes the control unit to determine the energizing time of the feeding motor based on an open voltage of the battery detected by the voltage detector before the rotation of the feeding motor.

4. A rebar tying device that ties a plurality of rebars by a wire, the device comprising:
- a feeder that feeds the wire wound around a reel by a rotation of a feeding motor;
- a guide that guides the wire fed by the feeder around the plurality of rebars;
- a cutter that cuts the wire fed by the feeder;
- a twister that twists the wire around the plurality of rebars;
- a battery that supplies power to the feeding motor;
- a control unit including a memory; and
- a voltage detector that detects a voltage of the battery,
- wherein the memory stores a program executed by the control unit to cause the control unit to:
- determine an energizing time of the feeding motor based on the voltage of the battery detected by the voltage detector during the rotation of the feeding motor, and
- control a feeding length of the wire by energizing the feeding motor for the determined energizing time.

5. The rebar tying device according to claim **4**,
- wherein the program stored in the memory causes the control unit to:
- determine a voltage drop of the battery based on an open voltage of the battery detected by the voltage detector before the rotation of the feeding motor and the voltage of the battery detected by the voltage detector during the rotation of the feeding motor,
- integrate the determined voltage drop of the battery over time to determine a time integration value of the voltage drop of the battery during the rotation of the feeding motor,
- determine an energizing time of the feeding motor based on the determined time integration value of the voltage drop of the battery during the rotation of the feeding motor.

6. The rebar tying device according to claim **4**,
- wherein the program stored in the memory causes the control unit to determine the energizing time of the feeding motor based on an open voltage of the battery detected by the voltage detector before the rotation of the feeding motor.

7. A rebar tying device that ties a plurality of rebars by a wire, the device comprising:
- a feeder that feeds the wire wound around a reel by a rotation of a feeding motor;
- a guide that guides the wire fed by the feeder around the plurality of rebars;
- a cutter that cuts the wire fed by the feeder;
- a twister that twists the wire around the plurality of rebars;
- a battery that supplies power to the feeding motor; and
- a control unit including a memory,
- wherein the memory stores a program executed by the control unit to cause the control unit to:
- determine an energizing time of the feeding motor during rotation of the feeding motor based on a predetermined length of wire and based on an induced voltage of the feeding motor during the rotation of the feeding motor, and
- control a feeding length of the wire by energizing the feeding motor for the determined energizing time.

8. The rebar tying device according to claim **7**, further comprising:
- a setter that sets the predetermined length of wire.

9. The rebar tying device according to claim **8**,
- wherein the program stored in the memory causes the control unit to:
- integrate a value of the current of the feeding motor over time during the rotation of the feeding motor to determine a time integration value of the current of the feeding motor during the rotation of the feeding motor, and
- determine the energizing time of the feeding motor based on the determined time integration value of the current of the feeding motor during the rotation of the feeding motor.

10. The rebar tying device according to claim **8**, further comprising:
- a voltage detector that detects a voltage of the battery,
- wherein the program stored in the memory causes the control unit to:
- determine a voltage drop of the battery based on an open voltage of the battery detected by the voltage detector before the rotation of the feeding motor and the voltage

of the battery detected by the voltage detector during the rotation of the feeding motor,

integrate the determined voltage drop of the battery over time to determine a time integration value of the voltage drop of the battery during the rotation of the feeding motor, and

determine the energizing time of the feeding motor based on the determined time integration value of the voltage drop of the battery during the rotation of the feeding motor.

11. The rebar tying device according to claim **7**,

wherein the program stored in the memory causes the control unit to:

integrate a value of a current of the feeding motor over time during the rotation of the feeding motor to determine a time integration value of the current of the feeding motor during the rotation of the feeding motor, and

determine the energizing time of the feeding motor during the rotation of the feeding motor based on the predetermined length of wire, the induced voltage of the feeding motor, and the determined time integration value of the current of the feeding motor.

12. The rebar tying device according to claim **7**, further comprising:

a voltage detector that detects a voltage of the battery,

wherein the program stored in the memory causes the control unit to:

determine a voltage drop of the battery based on an open voltage of the battery detected by the voltage detector before the rotation of the feeding motor and the voltage of the battery detected by the voltage detector during the rotation of the feeding motor,

integrate the determined voltage drop of the battery over time to determine a time integration value of the voltage drop of the battery during the rotation of the feeding motor, and

determine the energizing time of the feeding motor during the rotation of the feeding motor based on the predetermined length of wire, the induced voltage of the feeding motor, and the determined time integration value of the voltage drop of the battery.

13. The rebar tying device according to claim **12**,

wherein the voltage detector and the control unit are arranged on a same substrate.

14. The rebar tying device according to claim **7**, further comprising:

a current detector that detects a current of the feeding motor,

wherein the program stored in the memory causes the control unit to:

determine an induced voltage of the feeding motor during rotation of the feeding motor based on the current of the feeding motor detected by the current detector during rotation of the feeding motor, and

determine an energizing time of the feeding motor based on a predetermined length of wire and based on the determined induced voltage of the feeding motor during the rotation of the feeding motor.

15. The rebar tying device according to claim **14**,

wherein the current detector and the control unit are arranged on a same substrate.

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